OCEAN WASTE DISPOSAL ☆ C³I: AMERICA'S ACHILLES HEEL? ☆ SMALL HYDRO GROWING BIG

Technology Review

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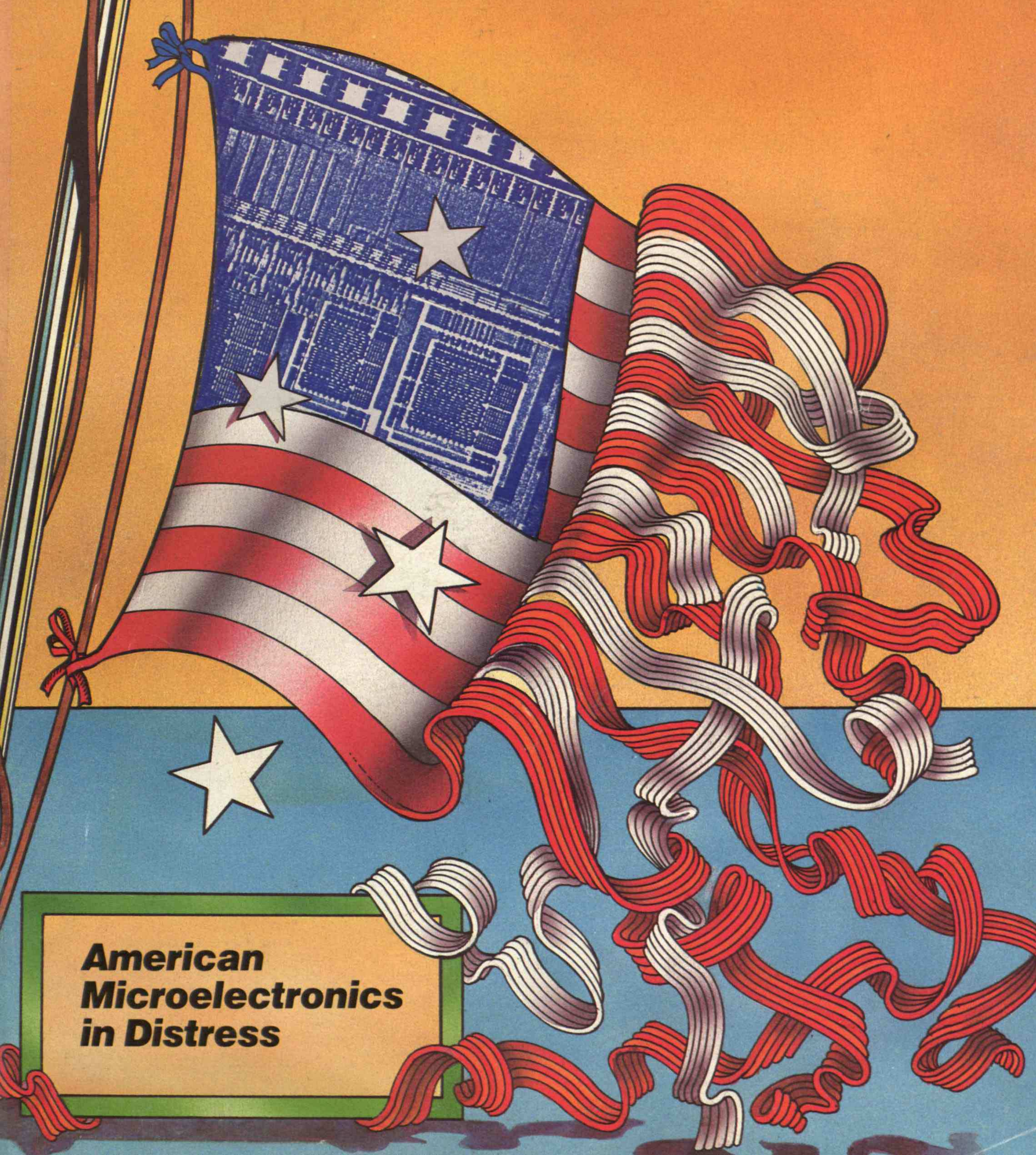

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23
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Based on years of racing experience, Porsche has designed the interior of the 928S to integrate the car and the driver as one.
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Some people ask why we put so much luxury in a performance car. And others ask why we put so much performance in a luxury car.
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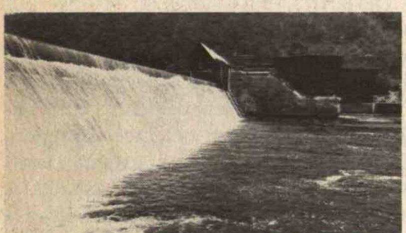

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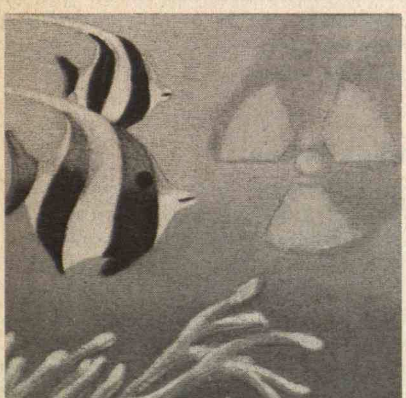

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LETTERS

Word Watch

In "Reindustrialization Past and Present" (*November/December, page 48*), Rosalind Williams presents a case for the Russian revolutionist Kropotkin. She prefers the word "capitalist" to "free enterprise" throughout the article and deplores high interest rates. These are aggravated by the deficit-spending practices of Congress, not by industry, which labors mightily to pay myriad taxes. No system is perfect, but free enterprise beats all other alternatives.
Clifford W. Bundy
Los Altos, Calif.

History Lessons

I was surprised to read in the caption to the photographs on page 66 (*"The Brooklyn Bridge at 100" by Blair Birdsall, April, page 60*) that the Tacoma Narrows Bridge was rebuilt on the same towers after the disaster of 1940. It is evident from the two pictures that the rebuilt bridge's towers are of an entirely different construction.
Philip D. Blanchard
New Haven, Conn.

In 1855, John Roebling wrote that the Wheeling Bridge "was destroyed by the momentum acquired by its own dead weight when swayed up and down by the wind. . . . A high wind acting on a suspended floor devoid of inherent stiffness will produce a series of undulations [that] will increase to a certain extent by their own effect until by a steady blow, a momentum of force may be produced that may be stronger than the cables." In 1940, David Steinman's Tacoma Narrows Bridge went down in a disaster exactly like that of the Wheeling Bridge. A year later, Edward Serrell's Niagara Bridge went down in a similar way. Certainly if designers had studied the history of their craft, they would have known better.
Frederick J. Hooven
Norwich, Vt.

Mr. Birdsall replies:
The misstatement about the towers was overlooked in proofreading. The original towers were damaged so severely during the catastrophe that it would have been unwise to attempt to patch them. The compelling reason was that traffic usage indicated the need for a wider four-lane bridge in place of the original two-lane bridge. This meant widening the tower tops. The whole design also required a tower that would resist a heavier vertical load.

Bridges were famous for blowing down in the wind a hundred years previously, and the designers of the Tacoma Narrows era were surely aware of that fact. But they did not learn from experience with structures of the nineteenth century, which were lighter than modern bridges.

John Roebling has been recognized as a genius for intuitive design. It is interesting to speculate on whether he would have used a wind tunnel to determine whether a bridge design required more stiffness, had he been indoctrinated, as were those of the Tacoma Narrows era, with the tools of mathematical analysis.

Closing Gaps

In "Designers and Engineers: Strange but Essential Bedfellows" (*February/March, page 70*), Ralph Caplan casts the issue of functional and aesthetic aspects of design as a problem between designers and engineers. But even user-oriented designers are not generally trained to deal with physiological and psychological aspects of people's reactions to products. Design is a team effort, and the design process will be effective only when that weak link is strengthened.
Richard H. Lyon
Cambridge, Mass.

Market Failure

David B. Goldstein's example of market failure does not take into account the costs to the consumer of shopping for a more efficient refrigerator (*"Refrigerator Reform: Guidelines for Energy Gluttons," February/March, page 36*). Consumers may be right in not spending their valuable time seeking monetary savings.

Dr. Goldstein also neglects to discuss a standard free-market solution to market failure. If the utilities can really save billions if people buy more efficient appliances, why don't they pay manufacturers to retool appliances and plants? They could also fund the necessary development programs so the consumer pays the same price for a more efficient appliance.
Steven Field
Philadelphia, Pa.
Continued on page 6

How to reconcile your obsession with efficiency and your obsession with owning a Mercedes-Benz.

The 240 D Sedan begrudges inflated driving costs as much as you do. It dazzles you with quality, not gadgetry. Its record for retaining value is superb. You have found an honest $24,000* automobile at last. And at last, you are driving a Mercedes-Benz.

The Mercedes-Benz 240D Sedan strives for levels of running efficiency that make it seem almost an outlaw among $24,000 automobiles today.

Its free-breathing overhead camshaft diesel engine feels capable of holding calmly at exalted cruising speeds from New York clear to California. Yet 32 est. hwy. and $\boxed{27}$ EPA est. mpg** is the price you pay in fuel.

Certain engine tolerances are no more than one hundredth of a millimeter. Such fine machining of key working parts is a Mercedes-Benz trademark. And a hedge against premature engine wear.

Mercedes-Benz engines–with proper care and upkeep, of course –seem to wear well. Over the years, the company's offer of radiator badges to owners clocking two hundred thousand, five hundred thousand and one million kilometers has had thousands of takers.

More than just numbers

But the 240D's joys transcend the numbers recorded in its owner's log. It encapsulates its extraordinary efficiency in an extraordinary vehicle.

Its undercarriage is one of its most exotic elements: a fully independent suspension system with diagonal pivot rear swing axle. Abrupt directional shifts prompt no wallowing. Bad roads are almost casually absorbed; how relaxing, not to veer away in panic from potholes.

◀ The Sky Harbor Photovoltaic Project, Phoenix, Arizona: This Mercedes-Benz 240D Sedan and the solar cell power plant surrounding it have an identical aim–to use energy as efficiently as possible.

Steering is acutely precise. A built-in steering system shock absorber intercepts ugly jolts. Even the springs in the seat beneath you are meant to serve as so many tiny vibration dampers, tuned as they are to the car's suspension motions.

You can select a four-speed manual or four-speed automatic 240D version. So efficient is this automatic that it barely affects fuel mileage. The shift lever is tunnel-mounted and so ergonomically correct that you can move it through the gears, manual style, without needing to take your eyes off the road.

Deep comfort

Like every Mercedes-Benz, the 240D ensures that you live well en route.

Your deep sense of comfort derives in part from a sense of spaciousness. The rear seat area is almost five feet wide, for example. The seats themselves are sculpted to complement the human anatomy, and firm-feeling because Mercedes-Benz knows this helps keep you comfortable-feeling over long trips.

The 240D is the most affordable Mercedes-Benz sold in America by some several thousand dollars. But there is only one Mercedes-Benz quality standard: thus light-alloy wheels and four-wheel disc brakes are among its standard items. Even electronic cruise control, central locking system, four-speaker AM/FM stereo radio with cassette player, and air conditioning are basic 240D equipment.

The carpeting underfoot is fine velour. The clock on the dash is a quartz crystal chronometer. Those delicate fillets of woodlike trim before you are all fillets of authentic, hand-rubbed zebrano wood.

Built with an eye to 1993

While it may not be the last car you ever need to buy, the 240D is built to help keep the conscientious owner off the new-car market for a good long time.

Its body is precision-welded at 4,786 points into a rigid steel unit. The whole structure undergoes a zinc phosphate bonderizing process to impregnate the steel with anticorrosion protection, and is coated five times with other primers and paint.

A car built with care can be backed with confidence. And the 240D is backed with a three-year or 36-thousand-mile warranty.†

When you buy the 240D, you buy an automobile with 120 individual safety features designed into it at the start. You also buy an automobile that has been shown, over the first three years, to retain 86 percent of original value.

The Mercedes-Benz 240D: seldom, if ever, have pleasure and efficiency and honest value for money been so gracefully combined in one automobile.

*Suggested retail price p.o.e. New York. West Coast prices slightly higher. **EPA estimate for comparison purposes. The mileage you get may vary with trip length, speed and weather. †This is, of course, a limited warranty; you should consult your authorized Mercedes-Benz dealer for full details.

Engineered like no other car in the world

Continued from page 2
U.S. appliance manufacturers are responding positively and effectively to this nation's need to conserve energy as well as to the "Japanese threat." Mr. Goldstein's example of a highly efficient cycle-defrost system illustrates a long-standing dichotomy between U.S. refrigerator-freezer engineers and those of other countries. Over the past 20 years, the U.S. market has swung to self-defrosting refrigerator-freezers while the rest of the world still uses partial-automatic and manual-defrost models.

The important question is whether Mr. Goldstein's concerns justify the problems inherent in government regulation of product design. The advantages of energy conservation must be measured against the limitations imposed by regulation. Designing with energy efficiency as the primary consideration means trade-offs in features, performance, and cost.
Robert L. Holding
Chicago, Ill.

Mr. Holding is president of the Association of Home Appliance Manufacturers.

Mr. Goldstein responds:
□ Whether consumers fail to minimize life-cycle costs of appliances because of the high cost of acquiring information or some other market failure is not important. When consumers cannot minimize costs, the economy suffers. Standards can eliminate the problem because consumers will not have to make the price-versus-efficiency trade-offs on an individual basis.
□ As regulated monopolies, utilities are restricted from acting in ways that could be viewed as anticompetitive. Thus, it would be hard for a utility to subsidize one manufacturer's appliances without being accused of unfair trade practices.
□ All but one of the five major Japanese refrigerator manufacturers produce American-style automatic-defrost refrigerators of much higher efficiency than American models. Only one manufacturer offers a "cycle-defrost" option in which the freezer compartment requires semi-automatic (pushbutton) defrosting every six months. This "button-defrost" model, made by Toshiba, freezes food more than twice as quickly as competitive fully automatic defrost freezers, resulting in higher-quality frozen food. None of the technologies described in the article implies sacrifices in reliability or features, and all are cost-effective.
□ If energy conservation were their primary consideration, manufacturers could design a refrigerator that uses far less than 420 kilowatt-hours a year. Although the appliance industry takes pride in the 59 percent improvement in refrigerator efficiency achieved from 1972 to 1981, Japanese companies recorded gains of 220 to 500 percent during the same period.

More on the Fridge

Efficient refrigerators produce more waste heat than inefficient models. This helps heat the house during the winter, but extra energy may be needed to run an air conditioner during the summer. I am curious what the net effect of these two situations would be.
John P. Rudy
Lexington, Mass.

Mr. Goldstein responds:
The contribution of internal heat loads, such as refrigerators, to reducing heating requirements is not very large. Even at optimal levels of insulation and in the worst climates, less than 40 percent of an appliance's waste heat is useful. It is most cost-effective to add insulation up to the point where internal loads have a minor effect on reducing heating needs.

Even if a significant fraction of an apppliance's energy consumption produced waste heat that reduced space heating needs, it still would not be cost-effective to use appliances as heaters. The heat is concentrated in one room of the house and is supplied at all hours whether needed or not. Also, appliance-delivered heat is essentially like electric resistance heat—a very expensive source.

In contrast, even in very warm climates, a large fraction of cooling loads is attributable to heat generated within the house. In a well-insulated house with shaded windows, reducing internal loads can often eliminate the need for an air
Continued on page 23

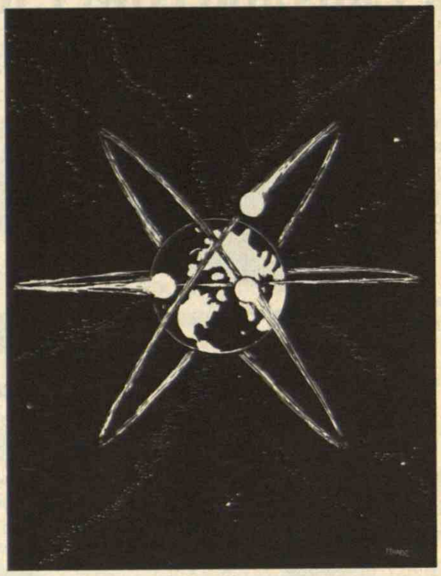
Toward International Unity in High-Energy Physics

Although the year is not yet over, 1983 has already turned out to be a "golden jubilee" for physics, to use the phrase of British physicist Frank Close. Would that it were as golden a time for U.S. practitioners of physics! It seems ironic that, a half-century after Enrico Fermi produced the first theory of the weak force, U.S. physicists should join their European colleagues in celebrating a deep new understanding of the force's nature, only to wonder if they will have the funds and powerful new particle accelerators needed to exploit these recent discoveries.

Modern theory asserts the essential unity of electromagnetism and the weak force, which is responsible for certain forms of radioactive decay. By "unity," physicists mean that, at sufficiently high energies, interactions involving what had seemed to be different natural forces will be indistinguishable from one another. Physicists also postulated the existence of three new fundamental particles—two *W* particles, one positively and one negatively charged, and the electrically neutral *Z* particle. The anticipated discovery of these particles, with the solid support this would give the theory, prompted Dr. Close to proclaim the jubilee last January. His announcement had scarcely appeared in *Nature* when the *W* particles surfaced at the European Center for Nuclear Research (CERN) at Geneva. Then in late spring, CERN reported the appearance of the *Z* as well.

Thus, the so-called "electroweak" theory of Shelden Lee Glashow, Abdus Salam, and Steven Weinberg, which won its authors a 1979 Nobel Prize, seems established, at least for now, as part of the foundation on which physicists are attempting to build a grander theory to unify all the basic forces in nature. This Grand Unification Theory—inelegantly refered to as GUT—has long been the holy grail in physics.

Actually, present GUT theories try only to unify electroweak interactions with the strong-force interactions that hold atomic



nuclei together. Concepts of how to include the remaining basic natural force—gravity—are quite speculative. Even with this limitation, GUT theories are hard to test directly. To produce definitive results, physicists believe they need to probe particles at energies a thousand times larger than any foreseeable accelerator can provide. (In an accelerator, various particles are boosted to tremendous speeds and hurled against other particles or test targets. Physicists then study the products of those collisions.) But the apparent success of the Glashow-Salam-Weinberg (GSW) electroweak theory encourages physicists to think they may be on the right track. They are eager to move on to higher accelerator energies that are feasible to test the GSW electroweak theory thoroughly. They also want to make sure no unsuspected modes of particle behavior lurk just beyond the energy limits of present research machines.

U.S. physicists are eager for bigger machines because they have had to sit by while major discoveries such as the *W* and *Z* particles have been preempted by Europeans. However, they will probably have to wait a while longer to see to what extent they can get back into the game. The Department of Energy's High Energy Physics Advisory Panel (HEPAP) met in Woods Hole, Mass., during the week of June 5 to weigh the options for new accelerators in what presidential science advisor George Keyworth had called a "watershed episode." But as late as mid-July, the panel had failed to reach a decision, and its members refused to comment on the discussions. But even if HEPAP does recommend a bold advance to achieve higher energies, any proposal would have to survive the uncertainties of the fiscal 1985 election-year budget process.

Physicists in Britain, too, feel constrained. They have no hope of obtaining a new accelerator of their own—they have to carry out their research at CERN, in which the United Kingdom is a partner. Yet a million pounds is being cut from their already modest five-million-pound budget for research equipment. Only in West Germany and at CERN itself do physicists hold a solid hope of progress with new machines that should go part way toward achieving the higher energies physicists desire. This thirst for ever-higher energies is inherent in the quest for a Grand Unification Theory.

The weak force, so named because it is a trillion times weaker than the strong nuclear force, is short range. It acts only over distances 1,000 times shorter than the radius of an atomic nucleus. The force's effects can emerge when the strong force or electromagnetic force is inhibited. Physicists think of particle interactions as mediated by the exchange of other special particles that are said to carry the force involved. For example, photons, the particles of light, mediate electromagnetic interactions. The weak force likewise has mediating particles—the intermediate vector bosons. They are "intermediate" because they mediate weak force effects. They are called "vector" because of their spin. "Bosons" are named after the late Indian physicist Satyendra Nath Bose, who, together with Einstein, developed the energy distribution for bosons.

In electroweak theory, these bosons are the prized *W* and *Z* particles. Together with the photon, they form a single family that represents the weak and electromagnetic forces. The electroweak theory correctly predicts that the photon has no mass. It also assigns masses to the *W* and *Z* particles that have also proved correct. But the predictions assume the existence of a still-undiscovered fourth boson named after Peter Higgs, whose work at the University of Edinburgh in 1964 showed how to assign the *W* and *Z* masses.

These particles are fairly massive. In terms of equivalent energy, the *W* and *Z* are around 80 billion electron volts (Gev) and 90 Gev respectively. (A billion elec-

ROBERT C. COWEN is science editor of the *Christian Science Monitor* and former president of the National Association of Science Writers.

ILLUSTRATION: DENNIS MOORE

tron volts is the energy an electron acquires when accelerated through a potential difference of a billion volts.) CERN's proton-antiproton collider is the first machine powerful enough to materialize these particles. In this machine, a beam of protons and a beam of antiprotons, each with an energy of 270 Gev, collide head on. Professor Abraham Pais of Rockefeller University calls the emergence of the *W*s and the *Z* from these collisions with their predicted masses "simply beautiful." He says, "What made the earlier discovery of the *W* such a moving moment was the confluence of theory and experiments."

Beautiful it may be, but CERN's collider produces *W*s and *Z*s slowly. Perhaps a dozen or less *W*s and five *Z*s were seen by June. Physicists want more energy and other types of machines to produce more of the particles. Also, while the GSW electroweak theory looks good, physicists won't be fully happy with it unless and until they find the Higgs boson, which requires producing more energy. And the GUT theories predict two new mediating particles, called noncommitally *X* and *Y*. They have enormous mass—on the order of 10 million Gev. While physicists can't hope to design accelerators of such energy in the foreseeable future, they still would like to work toward that range.

CERN is going ahead with LEP, an electron-positron collider with 50-Gev beams that may later be boosted to 100 Gev. The DESY laboratory in West Germany is also likely to get a high-energy electron-positron collider. Such collisions at the higher energies should give a better look at the *W*s and *Z*s. But U.S. high-energy physicists would like to do even better. Fermilab's trillion-electron-volt (Tev) proton accelerator recently started up as the highest-energy fixed-target machine in the world, and will be augmented to become a proton-antiproton collider by 1985. And Fermilab designers are talking of a successor with double that energy. Meanwhile, looking farther ahead, a number of physicists are promoting a 20-Tev machine, called the Desertron because it would be built on cheap desert land to accommodate its huge ring, that might be 150 kilometers in circumference. At 20 Tev, research would likely cross a new energy frontier.

Such are some of the options HEPAP was to weigh in June. After two years of keeping physicists on tight rations, the Reagan administration has indicated it is sensitive to the lagging status of U.S. research and is ready to do something about it. Science advisor George Keyworth has said he leans toward the Desertron, but interest is no guarantee of massive funding. Moreover, Dr. Keyworth has chided physicists for haggling over which institution gets what accelerator. He told the American Physical Society last April, "In the years American physicists squandered on a pork-barrel squabble, the Europeans moved boldly ahead."

Perhaps both Dr. Keyworth and U.S. physicists should also stop thinking in terms of international rivalry. High-energy physics is too costly and too interesting for parochial competition when cooperation at a superior American-European or American-Japanese, if not world, facility might better advance knowledge. After all, a number of U.S.-based physicists are members of the massive research teams at CERN that have made the recent discoveries. □

Why the Lead-Pipe Theory Is Dangerous to Our Thinking

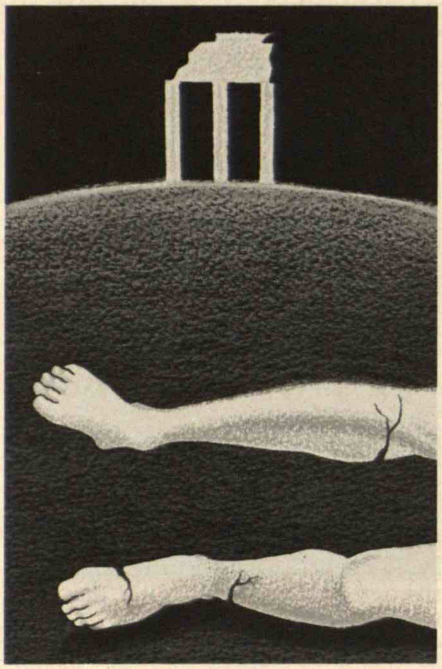
A CLUE TO THE DECLINE OF ROME

THE front-page headline in the *New York Times* captured my interest as the paper's editors knew it would. The decline and fall of the Roman Empire is a topic of perpetual fascination, and nowadays one's natural curiosity is heightened by the uneasy awareness that our own society is showing signs of decay.

The headline was occasioned by new evidence that the ancient Romans suffered from lead poisoning. Dr. Sara C. Bisel, an archaeologist and physical anthropologist from Rochester, Minn., examined the bones of 55 victims of the Mount Vesuvius eruption of A.D. 79 and reported her findings last May at the annual meeting of the American Association for the Advancement of Science. Dr. Bisel found that the bones contained a mean level of 84 parts per million of lead, which she concluded was significantly high. The bones of contemporary Americans and Britons typically have 20 to 50 parts per million; the figure has been as low as 3 parts per million in the remains of prehistoric Greeks.

It has long been known that the Romans used lead in water pipes and kitchen utensils, and that much of their food and drink was contaminated. A few historians have suggested that this so seriously affected the health of the citizenry that it brought about the collapse of the empire. Because the Romans cremated their dead, few bones are available for analysis. But according to the *Times* article, the recent discovery of a large number of skeletons at Herculaneum, near Pompeii, provided the opportunity for the new study. The mention of Herculaneum and Pompeii piqued my interest even more, since I visited those famous archaeological sites

SAMUEL C. FLORMAN, a civil engineer, is author of *Engineering and the Liberal Arts, The Existential Pleasures of Engineering*, and *Blaming Technology*. Late last year Mr. Florman was honored by the American Society of Mechanical Engineers with its Ralph Coats Roe Medal.



just two summers ago. At that time, it so happened, I had my own experience relating to lead and fallen empire.

Marvels and Maladies of Engineering

The ruins at Herculaneum and Pompeii are truly spectacular examples of ancient engineering and stirred in me strong feelings of professional pride. Most of my cotravelers, however, were British nontechnical types who seemed more interested in myths and statues than lintels and paving stones. Our tour leaders were classical scholars of great charm and erudition, but I thought that their praise of ancient engineers was excessively muted. "A nice piece of work," one of them admitted to me as we stood in front of a tower that even today would challenge the skill of a master builder, "but, after all, they had all those slaves!"

At site after site, marvels of engineering were ignored in favor of architectural niceties, until at Pompeii we came upon lead water pipes, and then technology suddenly took center stage. Everyone started to talk about the danger to an unsuspecting populace from the use of the hazardous material. "Always have to try something different, you engineer chaps," said one of my companions. "Tried to poison everybody in town," said another, chuckling, "just like today." It was all light-hearted raillery, but I felt that my good nature was being tested to its limit.

It is bad enough to ignore the vital contributions of engineering to the growth of classical culture, and to speak as if the most significant feature of a great stone column is not the miracle of its mining, transport, and erection but merely the carved decoration at its top. To then imply that technological advance brought about the downfall of ancient civilization—well, that is simply too much.

Those feelings of exasperation came rushing back as I read the *Times* article. The attribution of Roman decline to widespread lead poisioning has always seemed to me an untenable theory. Lead doubtless caused health problems, but there is no indication that the empire collapsed because of disease.

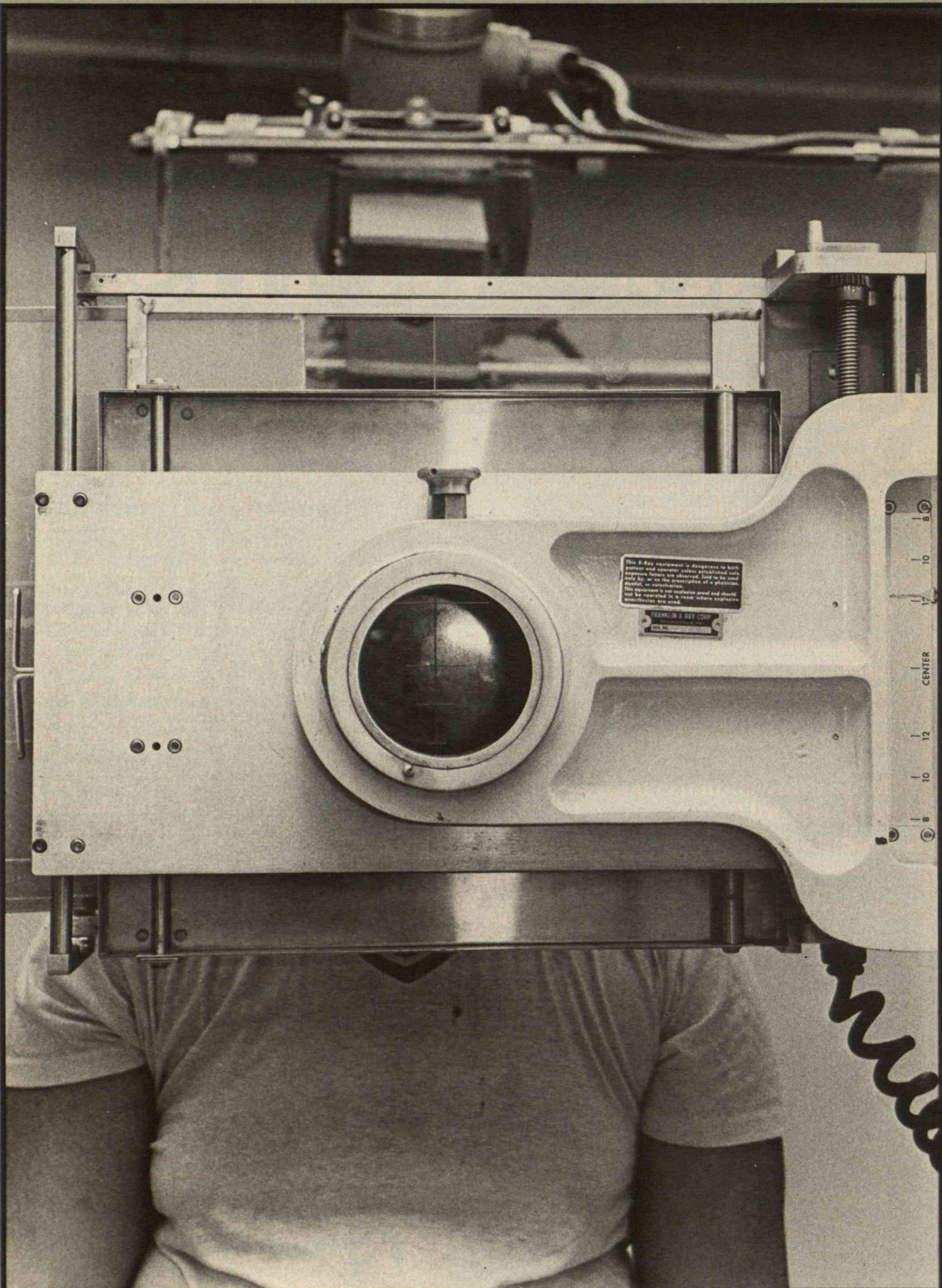
The great mystery about the Roman Empire is not why it declined but how it lasted as long as it did. Rome collapsed because it grew old and could not cope with social changes. Today we are grappling with the same problem: how to convert from a pioneer society to a mature one, or better, how to maintain the vigor of the pioneer and apply it to a new array of challenges.

Also, just as Rome did not collapse without being assaulted by the barbarians, so is America's decline tied to the rising demands of other societies. The problem in Roman times, as now, was never too much technology but rather too little to go around. If the tribes of the Asian steppes had been warm and well fed, they would not have invaded Europe. If, today, other societies were not competing with us over scarce resources and costly energy, we would certainly feel less threatened.

Historians tell us how the Asian tribes adopted many of the ways of the Romans; our competitors have done the same. We, however, are doing something that the Romans did not do—we are studying our challengers just as they have studied us, and are bidding fair to adopt some of their techniques for ourselves. I refer not only to Japanese management systems but also to Oriental methods of controlling personal stress, Third World alternative technologies (such as small methane generators), and sophisticated European trade practices. Our task is made somewhat easier in that we are not trying to conquer the world as the Romans were;

Continued on p. 22

ILLUSTRATION: JAMES STEINBERG


This X-Ray equipment is dangerous to both patient and operator unless established safe exposure factors are observed. Sold to be used only by, or on the prescription of a physician, dentist, or veterinarian.
This equipment is not explosion proof and should not be operated in a room where explosive anesthetics are used.
FRANKLIN X RAY CORP
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CENTER
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BY DAVID HELLERSTEIN

Overdosing on Medical Technology

> For too many dying patients, the barrage of testing and treatment continues without reason.

> We doctors have to learn how *not* to cut, how to stand back sometimes and let nature have its way.

A few years ago, when I was in medical school, I spent a long Sunday afternoon squeezing bags of blood. I was on Surgery service then, and had half a mind of becoming a surgeon—I loved the cutting and sewing, the urgent rush to the operating room, and the feeling of omnipotence that came from excising disease and suturing together what was left.

This particular Sunday, an old alcoholic was brought into the emergency room, nearly dead. His name was Kalicki (all the names in this article have been changed), and his bloated belly was rigid. His body had all the stigmata of the end-stage boozer—beef-red palms, dilated webs of veins across his stomach, spidery bursts of broken blood vessels on his face and chest. There seemed to be no question of what to do. The excited voices of residents and nurses filled the emergency room, as intravenous lines were started, blood was drawn, and catheters passed into stomach and bladder. Soon old Kalicki was in the operating room. His belly was shaved and prepped, and in a few minutes the surgeon had made an incision along the line of his ribs.

Kalicki's insides were a confusion of old scars and adhesions. With each slice of the surgeon's scalpel, each movement of a blunt probe, new blood bubbled up black from within. The electric bovie, which usually stops bleeding with its cauterizing jolt, only brought forth new oozing. Kalicki's pressure began to drop; the intravenous lines were opened wide. His pressure kept falling. The blood bank was notified of the state of emergency, and soon soft plastic bags of blood began to arrive. Plastic tubing was uncoiled, new lines were started in the arms and neck, and in a few minutes what seemed like a forest of weird maroon fruit with long purple stems hung over the table. Yet Kalicki's blood pressure stayed low.

That was when they told me to drop the retractor I had been holding and grab a bag of blood in my gloved hands. And to squeeze. I squeezed. I squeezed like hell. I must have squeezed a dozen bags until my hands went limp. Then somebody else took over, pushing hands together to force blood through the limp plastic tubing, frantically fighting to replace the deluge on the table. Of course it didn't work. Every suture put inside Kalicki's belly to stop the bleeding only brought new blood softly pumping to the surface. Finally, after 30-odd units of precious blood had traveled through Kalicki's leaky system, the chief surgeon said to stop. And everyone stood there in that stainless steel and tile room, gowned and gloved, as the pressure fell and Kalicki died. By the time somebody went to tell Kalicki's son, it was 7:30 at night; the day was gone. The son was not much surprised. Really, he said, it was for the best. The family had been expecting this for years.

That was it. Or almost it. A few weeks later, in the monthly morbidity and mortality conference, somebody brought up Kalicki's case, and mentioned a paper about the regrettably high incidence of uncontrollable bleeding in end-stage cirrhosis of the liver. Our chief commented that as soon as he made the first cut, he knew he wouldn't be able to stop the bleeding. But once he'd started, what choice did he have?

Pointless Displays of Technique

The events of that afternoon have stuck with me. Even without them I doubt I'd have been a surgeon, but they did cast a pall on the whole endeavor. What had looked so heroic now seemed bullheaded and pointless, a display of technique for its own sake.

At first such displays seemed peculiar to surgery, but as I finished medical school and began my internship and residency I began to see the same sequence of events played out over and over in different settings—in internal medicine, pediatrics, neurology, and oncology. Time after time we'd be there, in situations with no hope of survival. What I was seeing, I realized finally, was not an isolated phenomenon but something pervading the contemporary practice of medicine in America.

Certainly there are some situations where the motives for continuing aggressive treatment are more or less rational. If there is a slight hope of recovery, it's always difficult to stop treatment. And in an emergency, it's often better to act first and question later. Sometimes there are educational reasons for making a vigorous push—so interns and residents can learn to deal with the failure of multiple systems. Other times there's a need to experiment with a new drug or technique. Still other times I think there's a vague fear that lawyers might be sniffing around for malpractice possibilities or that an outraged family member might turn up after the fact. And in still other situations, unethical practitioners may perform extra tests for their own financial gain. But in many terminal situations, the barrage of testing and treatment continues without any apparent reason. The machinery of the hospital, once set in motion, just continues rolling.

These are the most baffling situations. For some reason we doctors don't seem to know how *not* to treat, how not to make the first cut, how to stand back and let nature have its way. To decide not to treat the pneumococcal pneumonia in a dying patient seems like negligence—even if it may be mercy. To leave a cancer drug on the shelf seems like a crime.

To some degree, this obsession with technology reflects a bias of our culture. But to blame this situation solely on our culture would be futile. It would also be a mistake, because the problem has as much to do with the habits of the medical profession as anything else. Over the past century, medicine has grown from being a relatively passive clinical discipline with an emphasis on the observation of disease into a scientifically based profession dedi-

PHOTOGRAPH: HAZEL HANKIN/STOCK, BOSTON

cated to the collection of data, the close monitoring of organ function, and above all the aggressive treatment of disease. The medical profession embraces—indeed, endorses—technology with little critical examination. It rewards overtesting and overtreating. And worst of all, it has trained an entire generation of doctors—mine—in certain attitudes and thought patterns that are often detrimental to patient care.

My own experience was a textbook example. I received my training in a medical center that prides itself on delivering highly specialized, state-of-the-art care. But along with my excellent formal education in high-tech medicine came a number of informal lessons that often led to bad treatment.

Technology Pays

One was the lesson of our patients' lab sheets. Every day, a new computerized record of all lab tests would be put into all the patients' charts; it was a record of all tests done since the person entered the hospital. By the time someone had been in the hospital for a few weeks, this record could amount to 30 or 40 pages. The sense one got from this was that it would be a good idea to order a whole new set of tests every day—to check against the day before.

A second lesson—which I occasionally wish I had learned better—was that technology pays. Technology gets people grants, promotions, tenure. The surest way to power in a medical center is to ally oneself with technology. I can think of one resident in my psychiatry program who has learned this lesson particularly well. When he heard that our medical center was about to get an NMR scanner, an experimental diagnostic device, he learned as much as he could about the new machine and its possible relevance to psychiatry. He became instrumental in writing up protocol for research on the new machine and in supervising the research. This affiliation has given him power—the power to control access to this device—and will eventually enable him to publish a stream of research papers that can only increase his standing among other psychiatrists.

In addition, technology reimburses its followers well. The anesthesiologist makes more than the pediatrician, and the internist who performs more procedures to make a diagnosis makes more money than the internist who does only a few.

A third lesson, not explicitly stated but obviously followed in practice, was that virtually everyone should be treated. Instead of acknowledging that one patient might stand a chance of being cured while another might only have his or her terminal pain relieved, our approach was that we should try to do everything for everybody. It was extremely difficult for us to step back and ask what our overall goals should be, or even more important, to find out what the patient might want.

The same lessons, apparently, are still being taught today. In the first major review since 1932 of what doctors study for their M.D. diploma, a panel of the As-

PHOTOGRAPH: CHRIS MAYNARD/STOCK, BOSTON

sociation of the American Medical Colleges (AAMC) found that medical students are being swamped by science and technology at the expense of basic healing skills. "Specialization and the rapid rate of advancement of knowledge and technology may tend to pre-empt the attention of both teachers and students from the central purpose of medicine, which is to heal the sick and relieve the suffering," was how the AAMC panel phrased it.

Aside from doctors' attitudes, another reason for the excessive use of technology has to do with its consumers—patients and their families. Technology often serves the purposes that religious ritual once did. Better than prayers or candles or offerings, technology conveys hope. For the dying patient, the lab test and the CAT scan are symbols of recovery, and the administration of drugs or futile emergency operations brings a certain degree of relief. For the family, there is also some consolation in the thought that everything that can be done is being done. "Intensive care" sounds like love, so the dying patient is surrounded by monitors and catheters and respirators.

Hiding Behind Machines

Technology is often used as a distraction as well—to avoid painful and difficult issues. During my internship, this happened with an old man dying of stomach cancer. Mr. Johnson came to my hospital floor in a terminal state. But before we'd let him die, we did an enormous workup: CAT scans of body and head, x-rays of soft and hard tissues, collections of all available body fluids. He spent days in radiology waiting for these tests. He was sure we'd cure him; he had great faith in medicine. He'd already gone through one regimen of anticancer drugs with no effect; we gave him a second, experimental regimen. When that failed, a third course was begun. The most difficult thing to recall in retrospect is his suffering, not only the pain of his disease but the long waits for tests and his extreme pain from the corrosive chemotherapy. He'd cry when the futile medication went through his IV. Only in the last day or so did he realize that it was having no effect, and then he began screaming that we were killing him. There was no way to console him.

He was wrong, of course—we weren't killing him, but we weren't doing him any favor either. We were just adding to his expense and suffering, misleading him with technology. Probably we, his doctors, were misleading ourselves too; the oncologists I was working with knew full well they couldn't save Mr. Johnson, but nobody could admit it. And that's the problem. Despite all the promise of medical technology, in the crucial moments, many of us are ashamed to admit how woefully inadequate it remains.

Technology serves still another function: that of communication. There is no

language anymore for sitting by the bedside; the doctor has no time for waiting and consoling. More and more, the monitor's beep and squeal replaces the doctor's voice. The sounds of communication in the hospital are not English words but the respirator and the CAT scan. Many patients, like Mr. Johnson, are falsely reassured by these sounds, only to learn too late that they mean nothing.

Whether serving as communication, ritual, habit, or evasion, medical technology fulfills often fundamentally dishonest purposes. It is expensive, wasteful, and not infrequently inhumane to communicate through machines. And it may not even improve doctors' ability to diagnose disease, according to a recent study by physicians at Boston's Brigham and Women's Hospital. The study was conducted to determine whether the new diagnostic hardware was making autopsies obsolete as a way of helping doctors learn from their mistakes. The investigators studied the results of 100 postmortem examinations performed at their hospital in 1960, 1970, and 1980, and they found that the percentage of diagnostic errors was about the same in each of the three time periods. So much for the infallibility of technology.

Learning How to Listen

What, then, can be done to remedy this addiction to machines, this technological fix? Ironically, sheer cost is forcing policymakers on the state and federal level to act. Already, five states have devised their own hospital-reimbursement plans based, for the most part, upon fixed fees for services. The Reagan administration is proposing a similar package that would replace the traditional Medicaid reimbursement system with one that establishes, in advance, prices for 467 specific diagnoses. If a hospital spends less than the set Medicaid price, it gets to pocket the difference, creating an incentive to hold costs down. However, under this system, hospitals may end up denying patients care beyond a certain arbitrary limit. Particularly needy patients may suffer, and I don't believe this approach will make doctors more selective in their use of technology.

Any truly effective changes must come from the medical profession itself. And the place to start is at the beginning—by changing the values taught in medical school. The AAMC panel has wisely concluded that students must be taught to pay attention to treating minor problems, compiling patient histories, and using fundamental instruments such as the stethoscope. I would also suggest instruction in how to deal with terminally ill patients and their families, how to rely less on tests and more on diagnostic judgment, how to listen to patients' concerns. Such courses should be required, beginning in medical school and continuing through the clinical years of training.

Furthermore, we should attempt to change the attitudes of doctors already out of school. Many practitioners, in an effort to keep up with the bewildering pace of clinical research, regularly attend conferences and read two or three professional journals a week. Why not hold conferences, sponsored by individual hospitals or medical associations, in which the questions of technological overkill are discussed regarding specific cases? Answers to questions such as what tests are unnecessary and at what point treatment should be abandoned become increasingly important as newer technologies emerge, as we implant artificial hearts as well as kidneys, as the prospect of artificial livers becomes less fantastic. We may soon face a day when all our hospitals will be filled with very ill people whose physical existence can be prolonged almost indefinitely but whose quality of life will be intolerable.

The Team Approach

I also think it essential that we get directly into the medical arena to affect decisions as they are being made. Most hospitals have professional groups that evaluate patient care, but these "utilization review" committees are not very effective in dealing with the problem of overtreatment. They basically want to make sure that some kind of active treatment—or testing—is underway; they don't look too closely at whether it's really necessary. In fact, these committees may sometimes encourage a frenzy of overactivity among doctors who don't even know whether a particular patient should be hospitalized.

What I propose instead is the team approach—a group of medical professionals who would go on regular hospital rounds to evaluate the use of technology in patient care. Such a team could be similar to the "pain team" I know of at one

hospital that evaluates the best approach to relieving the pain of terminal cancer patients. The team includes an internist, a neurologist, a psychiatrist, a social worker, and a nurse. Similarly, a "technology evaluation team" could be composed of an internist, an intensive-care specialist, a psychiatrist, a nurse, and a few patient advocates. Team members could work with doctors and patients to help them decide on reasonable treatment goals and on the best use of medical technology. Such teams could help restore medical technologies to their proper role as useful, but fallible, tools. Some doctors may perceive this kind of team as a threat to their own authority or as a potential source of embarrassment. But I think many would welcome the support in making difficult clinical decisions.

One final example. At the end of my internship, an elderly man, a Mr. Stone, came to my floor with severe heart failure. Despite high doses of all the right medications, his body filled up with excess fluid. He was almost unable to breathe; only by giving him intravenous Lasix, which increases the flow of urine, could his lungs be kept clear. I was shocked when his cardiologist, Dr. Evans, took me aside one afternoon to recommend that I stop giving Lasix. Dr. Evans said that Mr. Stone was not enjoying life anymore, that he was very unlikely to make it out of the hospital, that he, Dr. Evans, had discussed intensive care and dialysis with the Stones and they had decided against that kind of intervention, and that Mrs. Stone was suffering because of her husband's protracted illness.

I can't see it, I said—it's just a few squirts of Lasix every day. So I continued. Mr. Stone kept getting heavier and had more trouble breathing. Mrs. Stone was sitting at his bedside every day, suffering. So one day I decided that I was being ridiculous and did what Dr. Evans suggested. Mr. Stone died. Mrs. Stone cried and thanked me and went home.

I knew I'd done the right thing yet I felt strange, because I knew that if I *wanted* to I could have kept his heart going for quite a long time. It was very unsettling, after the kind of training I'd received, to just stand aside and let nature have its way. □

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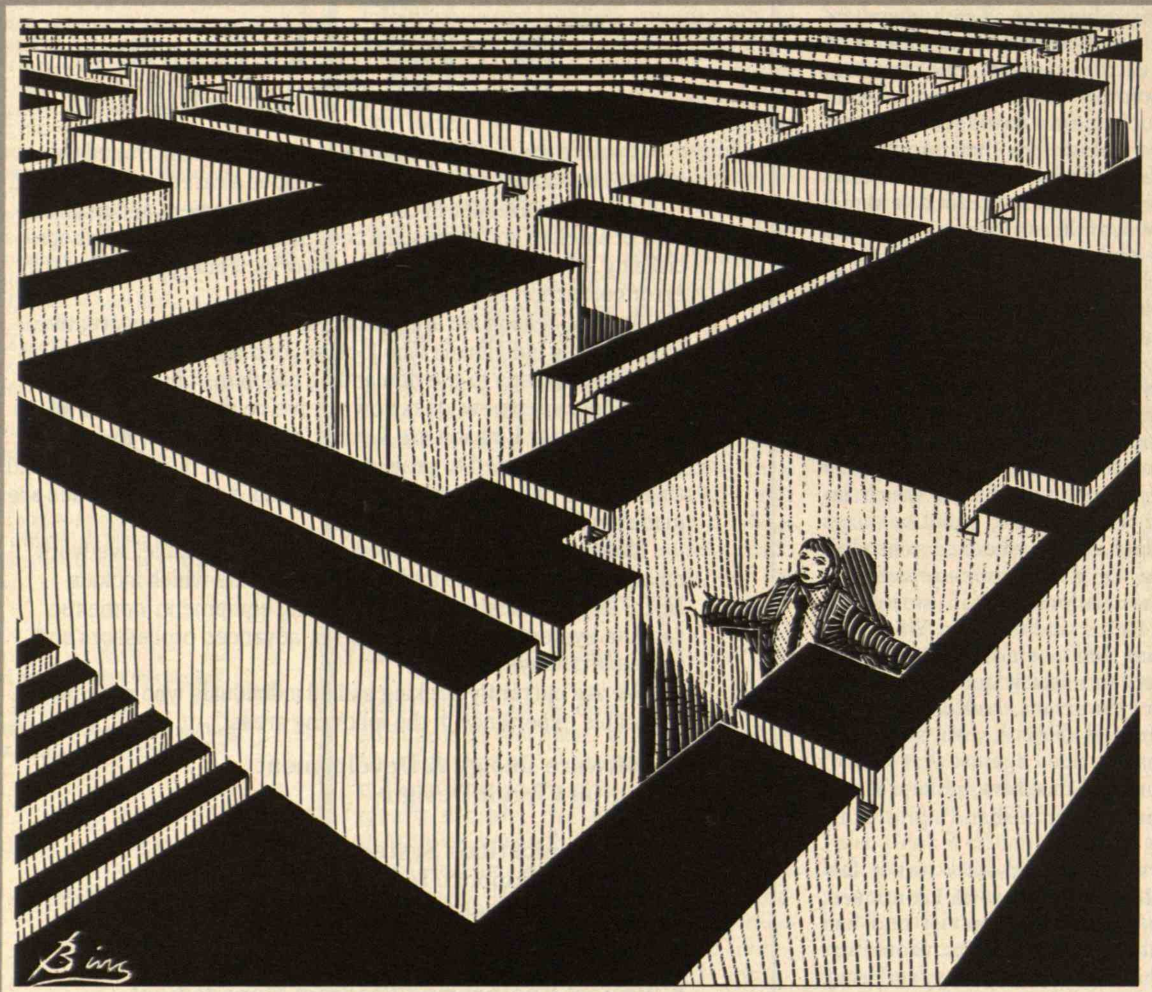
The Low-Skill Future of High Tech



BY HENRY LEVIN AND RUSSELL RUMBERGER

HIGH technology has become the nation's latest white knight, heralded as a means of creating many new jobs at home and restoring our economic supremacy abroad. Politicians and editorial writers even look to high technology as a way of upgrading the skills of the American labor force and increasing worker satisfaction.

To fulfill this promise, policymakers have proposed vast changes in our educational system. The New England Board of Higher Education recently endorsed an ambitious proposal from three high-tech consultants that calls upon government and industry to raise $1 billion for high-technology education. The House

ILLUSTRATION: CHRISTOPHER BING

of Representatives has already passed a bill that would provide $425 million to upgrade math and science education at the elementary, secondary, and college levels. Although most of the funds would be spent on improving the quality of teaching, $20 million is slated to recruit and train faculty in high-technology fields at junior and community colleges. The bill also provides at least $15 million to help develop programs in computer education. Other proposed federal legislation would provide tax credits to manufacturers who donate computers to schools; California already provides such credits on state taxes. Many states are also independently pursuing ways to increase the number of science, math, and computer courses required of all high-school graduates.

These proposed changes are based on two assumptions. First, future job growth in the United States will favor professional and technical jobs that require considerable education and training in computer-related areas. Second, high technology will require upgraded skills because workers will be using computers and other technical equipment.

Unfortunately, these assumptions are dead wrong. The expansion of the lowest-skilled jobs in the American economy will vastly outstrip the growth of high-technology jobs. And the proliferation of high-technology industries and their products is far more likely to reduce the skill requirements of jobs in the U.S. economy than to upgrade them. Therefore, America's policymakers should revise their educational priorities and place greater emphasis on a strong general education rather than a narrow specialized one.

Skilled Workers Need Not Apply

The Department of Labor has projected a faster rate of growth for high-tech jobs than for jobs in other occupations in the 1980s. While total employment is expected to increase 22 percent between 1978 and 1990, employment in data processing, machine maintenance, and computer programming are projected to grow between 70 and 148 percent.

But such percentage changes are misleading. The total number of new jobs generated in these and other high-technology occupations will be vastly outweighed by the number of jobs generated in other areas. For instance, the five occupations expected to produce the most new jobs in the 1980s are all in low-skilled areas: janitors, nurses' aides, sales clerks, cashiers, and waiters and waitresses. No high-tech occupation even makes the "top 20" in terms of total numbers of jobs added to the U.S. economy. While employment for engineers, computer specialists, and other high-technology professionals will grow almost three times as fast as employment overall, these occupations will generate only about 7 percent of all new jobs during the rest of this decade.

Statistics on specific occupations reinforce this picture. Employment for computer-systems analysts will increase by over 100 percent between 1978 and 1990, yet only 200,000 new jobs will actually be created. And while there will be 150,000 new jobs for computer programmers, some 1.3 million new jobs are projected for janitors, nurses' aides, and orderlies. Indeed, in each of these categories alone, there will be 9 unskilled jobs for every computer programmer.

As a whole, employment growth in the United States will favor the low- and middle-level occupations, according to the Labor Department. By 1990, jobs in all professional and managerial occupations will account for only 28 percent of all employment growth, less than in either of the previous two decades. In contrast, clerical and service occupations will account for 40 percent of total employment growth in the 1980s.

These estimates suggest that most job expansion will occur in areas that require little or no training beyond high school. Even if the number of high-tech jobs doubles or triples in the next decade, they will hardly make a ripple in the overall job market in America.

High technology will not ease our unemployment problems or upgrade workers' skills. Students, therefore, would benefit most from a strong general education rather than a specialized technical one.

The Minute Division of Labor

Job projections aside, there is no question that high technology will have a profound effect on many American jobs. Vast segments of the labor force will find their jobs altered by sophisticated computer technologies. Secretaries will trade their typewriters for word-processing equipment, bookkeepers will use computerized financial spread sheets, purchase and inventory employees will keep records on computerized systems, mechanics will use diagnostic systems employing microcomputers, and telephone operators will rely on computerized directories. But will the use of these new technologies require workers with more sophisticated skills?

Based on past experience, the answer seems to be no. Throughout the history of industrial production in this country, management has endeavored to divide and subdivide work into repetitive, routine tasks for which unskilled and low-paid workers can be used. This approach was first advocated by Adam Smith in *The Wealth of Nations* and later refined by Charles Babbage, who argued that it was cheaper to hire many workers capable of performing dissociated tasks than to hire a single worker capable of doing them all.

Technology has generally been used to aid and abet this division of labor. More than 20 years ago, James Bright, a professor at the Harvard Business School, examined the effects of automation on job-skill requirements in industries such as metalworking, food, and chemicals. The general assumption then, as today, was that increasing levels of automation required increasing skills. However, Bright observed that the skill requirements of

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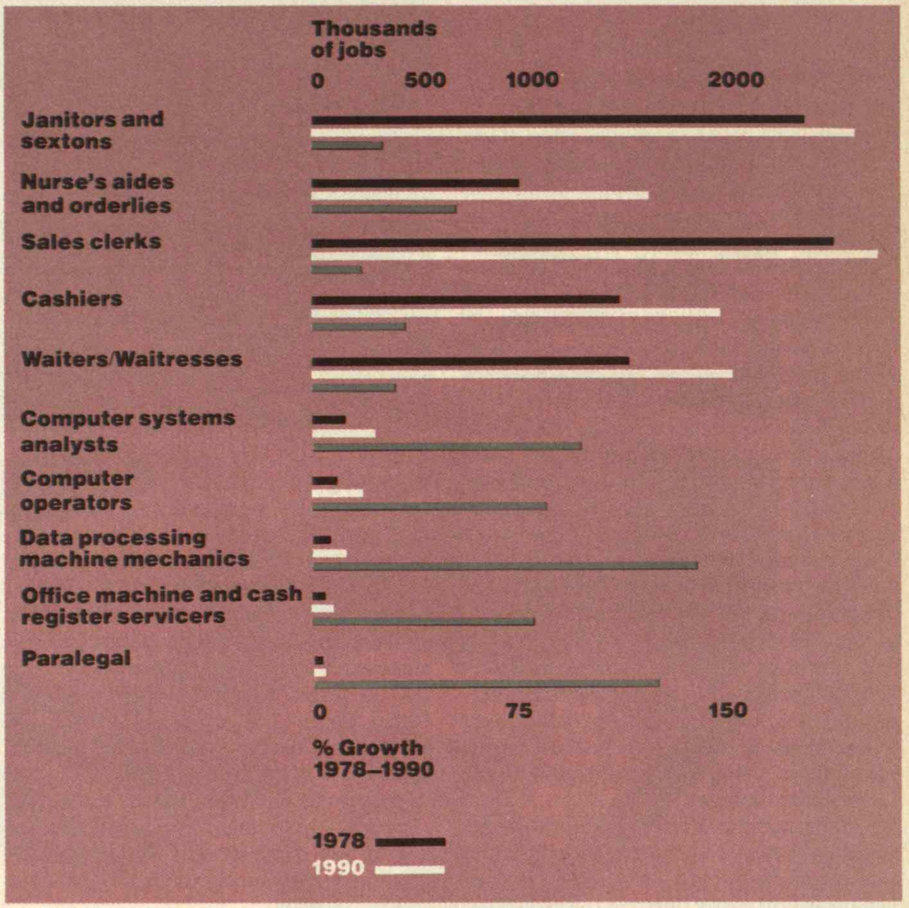
jobs first increased and then decreased sharply as the degree of mechanization grew. He found that in the long run, automated machinery tends to require less operator skill. Once operators master their particular machines, "Many so-called key skilled jobs, currently requiring long experience and training, will be reduced to easily learned, machine-tending jobs."

Our recent analysis of job-skill requirements in the U.S. supports Bright's conclusion. We compared Department of Labor data on job-skill training requirements for specific occupations in 1960 with those in 1976. We found that in spite of continuing advances in technology and the widespread shift toward automation, job-skill requirements have changed very little over the last two decades.

The impact of more recent technologies only reinforces this conclusion. Many of the jobs in the printing industry, for instance—typesetting, layout, and photoengraving—have historically required highly complex craft skills. But over the last 10 years, technological advances have enabled many of these operations to be performed by machines. The introduction of teletypesetting machines have eliminated many manual typesetting operations. Tasks that once required handling and proofing of metal plates and castings can now be done with paper—and soon by computer. Many manual operations involved in reproducing photographs have been automated. Complete layouts can be duplicated and transmitted to distant presses with a high degree of precision. Taken together, these advances have sharply reduced the skill required of workers who remain in the composing room.



Danger Signs of High Tech

Computers, which are at the very heart of the high-technology revolution, provide another textbook example. Early computers were not only large and expensive by today's standards; they required programmers and operators with fairly complex skills. But as computer languages become more "user-friendly," the level of skills needed to operate computers declines.

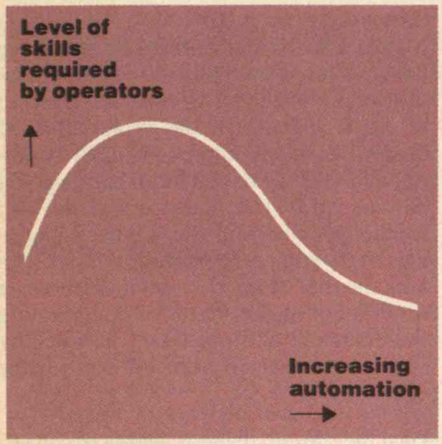
The new generation of office computers is specifically designed so that workers can use computers for a wide variety of tasks without any knowledge of computer languages. In the office, computers now perform many of the tasks formerly done by secretaries. Word processors can correct typing errors automatically by the use of electronic dictionaries, so letter-perfect typing and strong spelling skills are no longer required. In addition, each operator's performance can be monitored by the computer so that supervisors can instantaneously compare productivity among workers.

Ironically, high technology could be used to enhance the quality of working life and increase the level of worker skills. At General Motors, for instance, managers and workers meet regularly to discuss new assembly-line technology and analyze how it can be applied to give workers a greater sense of responsibility on the job. But whether these meetings will actually accomplish anything remains to be seen. Judging from the past, we have every reason to believe that future technologies will continue to simplify and routinize work tasks, making it more difficult for workers to express their individuality and judgment.

The danger signs are already evident in places such as Silicon Valley. Although some executives, programmers, and engineers are stimulated by their jobs, most workers in the valley are employed as office workers, assembly workers, and low-level technicians. Many are overeducated for their jobs and find little challenge from high tech. That may be why, according to a recent front-page story in the *San Jose Mercury*, a third of all workers in the valley take drugs and drink on the job. According to local narcotics agents quoted in the article, drug users in these plants are believed to be largely responsible for thefts on the job as well as accidents.

Just as ominous is the possibility that high tech will eliminate more jobs than it creates. Researchers at the Robotics Institute at Carnegie-Mellon University estimate that in the next 20 years, robotics could replace up to 3 million manufacturing positions involving operating machin-

DIAGRAMS: OMNIGRAPHICS



(Left) The Labor Department has projected a faster rate of growth for high-tech jobs than for other jobs in the 1980s. (See the gray bars.) But the percentage increases are misleading. The actual number of new jobs generated in high-tech professions will be vastly outweighed by the number of new jobs in low-skill occupations. (See the white bars.)

(Above) More than 20 years ago, James Bright, a Harvard Business School professor, examined the effects of automation on job-skill requirements in the metalworking, food, and chemical industries. Bright found that skill requirements first increased and then decreased sharply as the degree of automation grew.

ery, and potentially eliminate all 8 million of these positions by the year 2025. The widespread use of computer-aided design may virtually eliminate the occupation of drafter in the not-too-distant future, a potential loss of 300,000 skilled positions. A recent study from the Upjohn Institute estimates that robots could eliminate three times as many jobs as they will create, and the Director of Advanced Products and Manufacturing at General Motors predicts that the "factory of the future" will employ 30 percent fewer workers per car because of robotics. Even if laid-off production workers are retrained for high-tech positions, they may not be able to achieve a comparable income level. Placement counselors in Michigan found that laid-off steel or iron workers retrained for high-tech positions and lucky enough to find jobs typically received wages at half their previous level.

Another danger from high tech is that it may facilitate the transfer of production overseas, further reducing the number of jobs available in the United States. Much high tech assembly requires no more than a primary education, and many countries in the world can provide workers with such qualifications at less than $1 an hour. Atari's recent announcement that it was shifting most of its manufacturing facilities to Taiwan and Hong Kong illustrates this danger. As a result of this move, some 1,700 workers in Silicon Valley—middle managers as well as production workers—will be laid off.

Whereas past technical innovations primarily displaced physical labor, future technologies, rooted in the microelectronics revolution, threaten to displace mental labor. Entire classes of skilled or semiskilled workers can be made obsolete by sophisticated software packages.

Adapting to a High-Tech World

Obviously high technology is not going to be a cure-all for our nation's economic woes. And its potential impact on the workplace and society in general could be a lot more disturbing than we'd like to think. What, then, are its implications for education?

To begin with, an excessive emphasis on specialized schooling will not prepare workers for the future. Although many workers will need to acquire new knowledge to adjust to technological change, they will probably have to learn different, rather than more demanding, skills. Most of these new skills can best be acquired on the job and through short training courses rather than through expanded science, math, and computer-programming studies.

In fact, in a recent survey of industrial employers in Los Angeles conducted for the local chamber of commerce, Wellford Wilms, professor of education at UCLA, found that they prefer employees with a sound education and good work habits to those with narrow vocational skills. A similar survey of British companies seems to confirm employer preference for workers with a good attitude and a sound education.

In the future, technological advances will come at an increasingly fast pace. Specialized job skills will be more rapidly rendered obsolete and the once-familiar work environment will change at a bewildering rate. We believe that the best possible preparation for adapting to this lifetime of change will be a strong general education. By that we mean a knowledge of different political, economic, social, and cultural tenets as well as the acquisition of strong analytical, communicative, and computational skills. These are essential for understanding the currents of change in society and for adapting to such change constructively.

This approach should also fulfill the need to provide a common educational background for all students that will best serve the democratic interests of our society. A democratic society requires that citizens be qualified to understand the major issues of the day, discuss them, and take appropriate action. Early specialization not only deprives students of the general knowledge and skills needed to adapt to a changing labor market; it also fails to provide the basis for democratic participation.

In a high-tech future, a solid basic education will become more, not less, important. The challenge of the schools will be to upgrade the overall quality of instruction by attracting the best talent society has to offer. This will require major curriculum improvements, competitive professional salaries, and a much greater commitment to educational quality on the part of teachers, parents, policymakers, and society in general.

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Continued from p. 10

we just want to maintain the standards we have achieved and protect our opportunity to improve them. We see the salvation of the world not in the exploitation of others but in the improvement of conditions for all. We have a lot of things going for us that the Romans did not: technologies beyond the wildest imaginings of the engineers of antiquity, statistics and theories from the social sciences, a tradition of justice that is more appealing than Rome's, and not least, the humility and wisdom gained from our knowledge of history.

Dealing with the Consequences

There is, to be sure, a valuable lesson in the *Times* article. It relates not to the arena of crashing empires but to the important field of public health. Throughout history, technical innovations have had adverse consequences for human health that were not anticipated. When pumps were developed, for example, the need for aqueducts diminished, and drinking water was obtained from rivers and wells in or near cities. As a result, contaminated water caused diseases that had not been a problem when the water came pure from distant mountains. Such predicaments bedevil us to this very day, so it is instructive to consider case histories wherever they may be found.

However, when a cautionary tale about public health is transmuted into a fairy tale about history, I fear that we are losing our sense of reality. If we divert ourselves with false historical theories, we reduce our capacity to address the problems at hand. If we think that Rome fell because of its plumbing and cookware, we will be less apt to think in terms of world commerce and global understanding.

Our civilization will survive only if we address the great problems of economic development, social justice, and world peace. As for pollution and other "technological" causes of public anxiety, political approaches are often what we lack. Engineering solutions are at hand or could soon be developed if we were willing to accept the costs—economic and otherwise. I hope that some day historians do not look back and say that we refused to face up to the challenges of our time, and that we fell into the habit of blaming technology for the very decline it might have helped avert. □

Continued from page 7

conditioner entirely. Overall, the effect of waste heat from appliances on the heating and cooling needs of a house changes the economics of appliance efficiency only minimally. For most climates, the adjustment slightly favors efficiency improvements.

Unfurled in Space

I assume the flag in the upper lefthand corner of the space station depicted on page 38 of the April issue (*"Managing the Enterprise in Space" by Harvey Brooks*) was meant to be the Canadian national standard. The Canadian flag is a red maple leaf centered on a white field bounded on the inner and outer edges by red stripes extending from top to bottom.
Gerry Blackburn
Winter Garden, Fla.

Man Versus Pac-Man

Carolyn Meinel dismisses neighborhood reaction against video arcades as groundless or hysterical in "Will Pac-Man Consume Our Nation's Youth?" (*May/June, page 10*). Unfortunately, I live only half a block from an arcade that was plunked down on a commerical strip in the midst of a residential area in Cambridge some years ago. What was a relatively calm area has become, according to the police, the highest crime area in the city (most crimes being of the "petty" variety Ms. Meinel regards as fantasy and of which I have been a victim nine times since the facility opened). Her unwillingness to recognize that criminal activity is attracted to video arcades shows a parochialism that can only further polarize the issue. Having been labeled an "anti-video-game prissy," I wonder whether Ms. Meinel proposes that I stand up and take crime like a man.
Peter J. Wender
Cambridge, Mass.

In "Automatic Experts for Sale" (*May/June, page 84*), Teknowledge, Inc., was credited with developing the expert system Dipmeter Advisor. That system is the product of Schlumberger Ltd. The Teknowledge system referred to in the article is being used as a drilling advisor.

Personal Computers Needs: Help Wanted?

Using a computer to do research is not as easy as it appears in "Personal Computers: Passport to the Electronic Universe" by Alfred Glossbrenner (*May/June, page 62*). Owners of personal computers may want to consult "information specialists," who are located throughout the country at universities, libraries, and the private sector, about the fine points of searching and the unique characteristics of individual databases. These information specialists can help with special tasks such as retrieving actual documents, arranging interlibrary loans, obtaining hard-to-get data, and even doing technical writing and editing.
Edith F. Anderson
Del Mar, Calif.

"Intermediary assistance systems" that help microcomputer users gain access to and search online bibliographic databases are now available. Such systems give personal computers great advantages over the simple "dumb" terminal.

Future prospects are even more intriguing. Expert intermediary assistants promise to allow both experienced and inexperienced users to tap online information systems more simply and effectively.
Richard S. Marcus
Cambridge, Mass.

At Mr. Glossbrenner's suggestion, I dialed into the Novation Computerized Bulletin Board System (CBBS) to get a free list on my HP 125 microcomputer with a Bizcomp 1012 modem. When I used EVEN parity, I received lots of garbage. When I set my system on NO parity (the eighth bit forced to zero), all was well.
Marc Barman
Cupertino, Calif.

Mr. Glossbrenner replies:
I took the opportunity to write Novation a letter (one of the options on the menu) asking if they had changed things since last fall when I wrote the book from which the article was condensed. I can only assume that they have, because I signed on back then at 7/EVEN/1, full dupe, and had no trouble. I'm sure of this because no protocol settings are given in my source for the Novation information.

The Microelectronics Industry in Distress

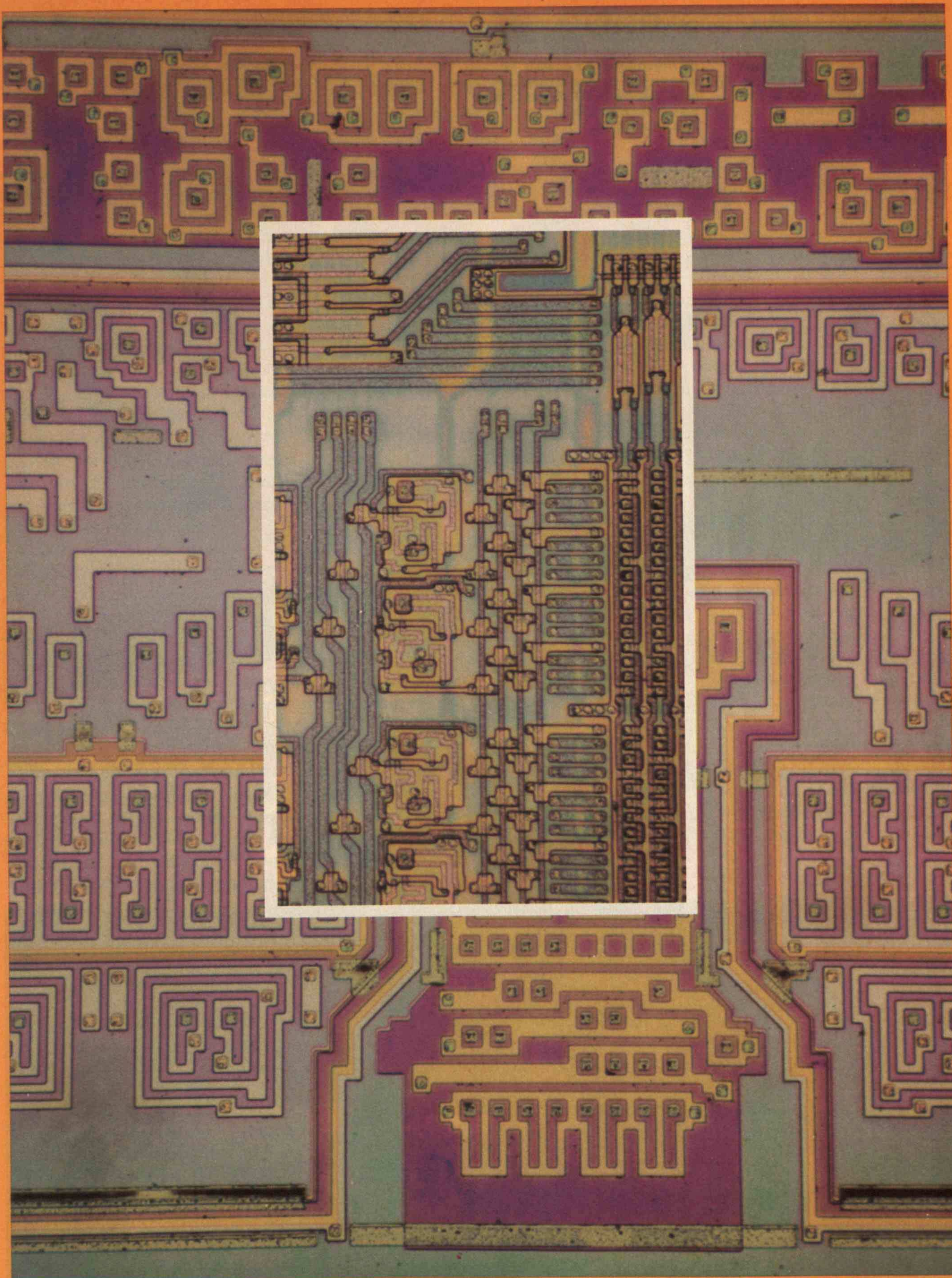
As new technologies transform microelectronics, the U.S. industry is plagued by an outmoded structure. Drastic remedies are needed or the entire economy will suffer.

BY CHARLES H. FERGUSON

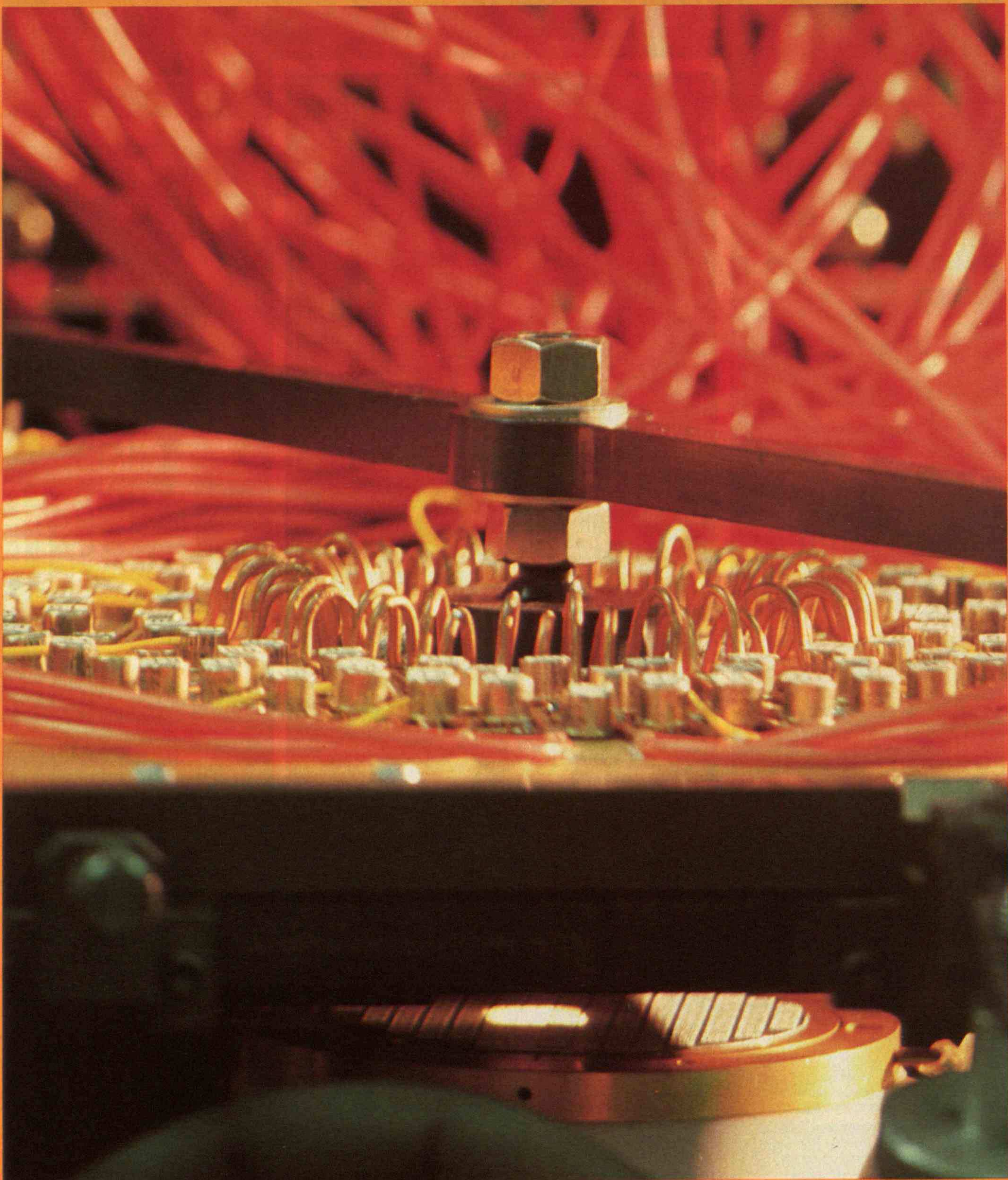
SUGGESTIONS of trouble in the U.S. microelectronics industry have been widely reported. For example, Japan leads the United States in manufacturing and selling 64K RAMS (random-access memories)—silicon chips used in computers to store approximately 64,000 pieces of information. And while four Japanese manufacturers already have prototypes of the more advanced 256K RAMS and two more are close to having prototypes, only two firms in the United States have progressed this far. Japanese companies have begun to sell advanced supercomputers, and Japan's Fifth Generation Computer Project, seeking radical technological advances, has no true U.S. counterpart. Efforts such as the Microelectronics and Computer Technology Corp. (MCC), a consortium of U.S. firms, are responding only slowly to these challenges. But what is at stake is more than the profits of a few semiconductor firms; it is the future health of the U.S. economy.

During the seventies, microelectronics "merchant" firms such as Intel and Fairchild made chips using large-scale integration (LSI) technology (shown in the bigger image). LSI chips were then assembled into computers or control systems by "systems" firms such as Control Data and Honeywell. Today one powerful chip made with very large scale integration (VLSI) technology (shown in the inset image at the same magnification) can substitute for an entire system. Thus, the structure of the U.S. microelectronics industry, based on separate merchant and systems firms, is becoming obsolete.

PHOTOGRAPHS: M.I.T. ARTIFICAL INTELLIGENCE LAB



This automated testing device can evaluate 100 million electric signals in a computer chip per second. Testing these chips for errors manually is impractical because state-of-the-art technologies squeeze more than 100,000 transistors onto a single chip. Thus, computerized testing is essential to the commercial success of the latest semiconductor technologies.



Most Japanese circuits are assembled with automated equipment. In contrast, most circuits sold by U.S. firms are assembled manually in Third World countries.

As always, when quantum changes occur in an industry, their significance is hard to appreciate at the time. Developments in electronics have been further obscured by that sector's volatile and complex history. An earlier period of technological change beginning in the fifties overtook the leading firms of that day, the vacuum-tube manufacturers. This early transformation of the electronics industry gained momentum in 1956, when AT&T agreed with the Justice Department in a consent decree to license its patents on the transistor in exchange for keeping its telephone monopoly. It was already clear that the transistor could do anything the vacuum tube could, namely amplify electrical signals, such as in radios, and perform mathematical and logical operations in computing devices. But the transistor's long-run potential was not so clear.

Made of "semiconductor" materials that may either conduct or not conduct a current, transistors are far more compact and durable than vacuum tubes, use far less electricity, and produce far less heat. Between 1956 and 1962 new firms such as Shockley, Fairchild, and Texas Instruments developed economical ways to manufacture integrated circuits, in which many transistors are cheaply combined on one silicon chip. "Systems" firms such as IBM, Honeywell, Control Data, and Sperry Univac began to combine large numbers of integrated circuits to make computers. In marked contrast to roomfulls of vacuum tubes, computational devices using integrated circuits could be made inexpensive enough for widespread commercial and military use. A new industry was born, in which the vacuum-tube firms played little part.

Spurred in the beginning by military purchasing policies, the semiconductor industry rapidly gained momentum. Small-scale integration (SSI), with up to about 10 transistors on a single chip, gave way to medium-scale integration (MSI), with up to 100 transistors. By the seventies large-scale integration (LSI) technology, with thousands of transistors on a chip, made possible the mass production of memory chips to store data and logic chips to perform calculations.

By this time, the U.S. microelectronics industry gained structural stability as U.S. "merchant firms," semiconductor manufacturers selling mass-produced chips, continued to grow and dominate world markets. Their largest customers were the computer systems firms. Others included manufacturers and defense contractors who assembled the standard chips into electronic-control devices for robots, telecommunications equipment, and other electronic products.

At the same time, LSI technology made it possible to fabricate powerful custom chips to perform specific functions. Systems firms had a particular need for custom chips, which were often vital to the commercial success of their products. Thus, to protect proprietary information, these firms set up their own research, design, and production operations for custom integrated circuits. For their part, the merchant semiconductor firms found it impractical to develop the special technology required to design and produce short runs of custom circuits. A few tried selling custom LSI circuits but had little success, so these firms concentrated largely on mass production of standard memories, microprocessors, and logic chips.

This structure of the industry did not seem overwhelmingly important at the time. However, it is proving to be poorly suited to producing very large scale integration (VLSI), developed in the late seventies, in which hundreds of thousands of transistors are embedded on a single silicon chip. VLSI is not merely another incremental improvement in technology. Rather, with VLSI, single chips produced by semiconductor manufacturers will soon compete in performance and speed with large systems of chips assembled by computer firms. This upsets the traditional division between semiconductor and systems companies. In the future they will increasingly employ the same techniques and compete for the same markets.

For example, the Hewlett-Packard 9000 microcomputer has as its central processing unit (CPU)—the core of a computer—a single VLSI "microprocessor" chip containing 450,000 transistors. Though the HP 9000 costs around $40,000 and sits on a desktop, it competes with larger "minicomputers" that have dozens of electronic chips in their CPUs, are the size of refrigerators, and cost hundreds of thousands of dollars.

That is only the beginning. The HP 9000 and other similar computers can perform 1 million instructions per second and have capabilities that border on those of a large mainframe computer. It is widely conceded that within a few years microcomputers—computers based on single-chip microprocessors—will push further into the mainframe category, performing 3 million calculations per second. Such "micromainframes" will compete with standard mainframes hav-

PHOTOGRAPHS: IBM

The military sponsors research on high-speed circuits with a sapphire backing, but these costly circuits have little commercial use.

ing hundreds or even thousands of individual chips in their CPUS.

The trade-offs possible in designing any computational device such as a computer or machine-tool control mechanism will become increasingly significant. To do a given job, a single custom chip may be designed, a piece of hardware may be constructed of many simpler chips, or a general-purpose microprocessor on a single chip may be specially programmed. Firmware—programming embedded in a chip—provides a compromise between pure software and pure hardware. Furthermore, to be effective, diverse pieces of equipment must be designed to communicate with one another. This requires standardization and compatibility among many products.

Given the division in the United States between semiconductor and systems firms, no one firm is in a position to make a whole spectrum of standardized products and to take optimal advantage of these trade-offs. The sole possible exception is IBM, the largest U.S. firm, which manufactures computers, semiconductors, and a wide variety of electronic products. While its size and scope give IBM unique opportunities to exploit advances in microelectronics, the company has proceeded slowly in some important areas. Committed to mainframe technology, it long ignored microprocessors: IBM uses a microprocessor manufactured by Intel in its Personal Computer. IBM has recently tried to rectify this shortcoming by purchasing 12 percent of Intel and launching a cooperative project with Carnegie-Mellon University involving the design of a 32-bit microprocessor. However, the result of these efforts remains in doubt. Equally important, no other U.S. firm even approaches IBM's size and technical strength.

By contrast, Japanese computer manufacturers such as Hitachi, Fujitsu, and Nippon Electric Co. (NEC) are in a far better position to take advantage of advances in microelectronics. These firms belong to *kieratsu*—large families of companies that include robotics, semiconductor, and other high-technology firms. *Kieratsu* have ready access to relatively inexpensive, long-term financing, frequently through special relationships with banks, so member firms are able to plan large purchases of capital equipment. The *kieratsu* are better prepared than U.S. producers to make optimal decisions regarding technology and strategy, such as whether to sell a given product—a chip, a system, a software package—on the open market or to reserve it for internal use.

While a U.S. firm is producing the world's first micromainframe, the Japanese are well positioned for future competition in this market, and in three to five years, U.S. firms may find themselves in difficult straights.

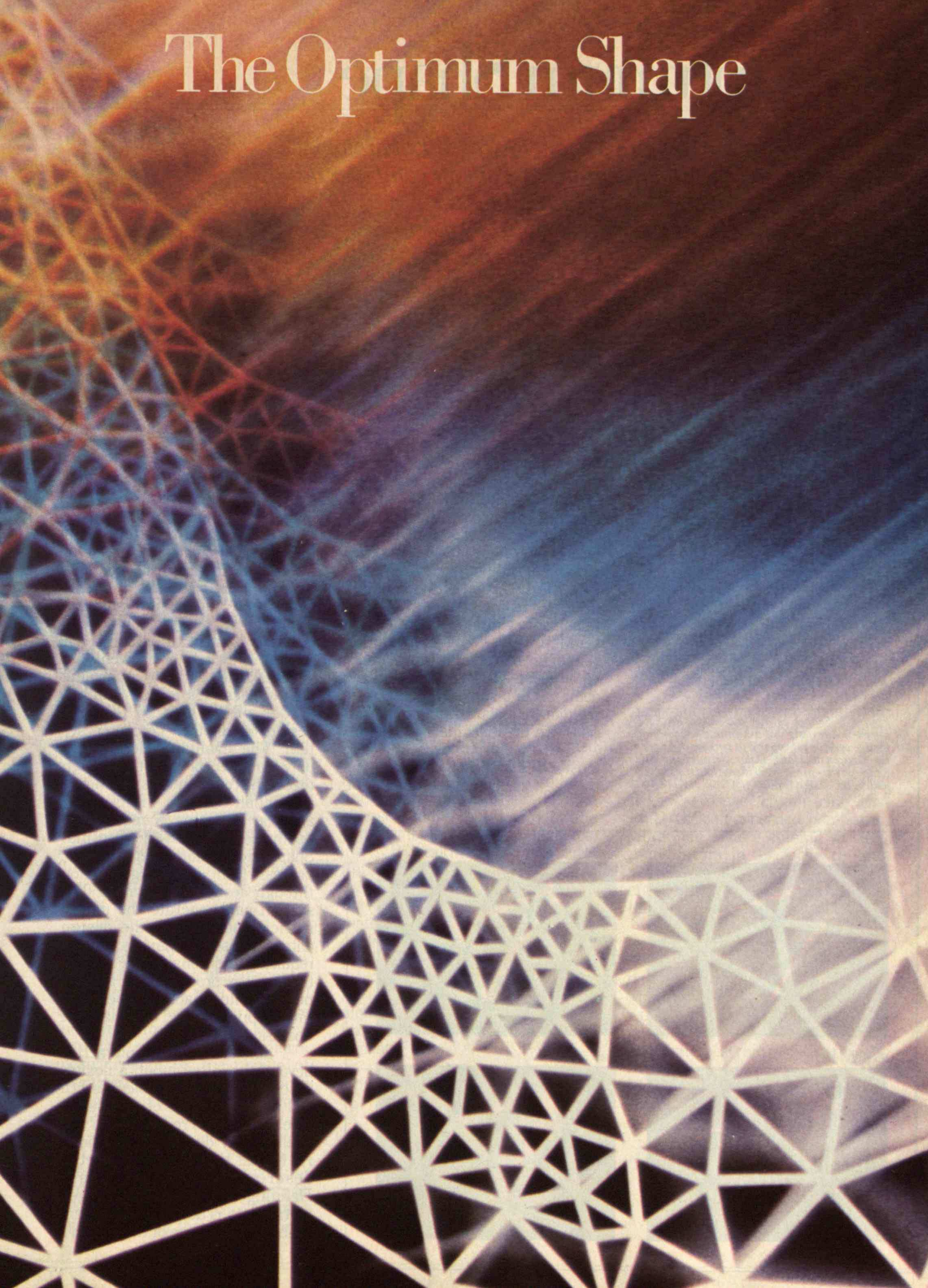
From Memory to Logic

Gaining a better understanding of how the Japanese have exploited VLSI technology requires taking a closer look at the manufacturing process for micro-electronics, especially memory chips. Semiconductor memories first appeared in 1971 with LSI technology. Though they are generally the simplest chips to design, they are used in the largest numbers and represent a very large market. Consequently, equipment for producing and testing memory chips is usually the most automated and advanced. Furthermore, memory circuits are a good proving ground for manufacturing: mass production of simple devices permits firms to statistically analyze defects and correct errors. Design rules—for example, the distance in microns by which transistors must be separated on a chip—are established. A firm that has fine-tuned the design, production, and testing of memory chips will therefore be able to more efficiently manufacture other, more sophisticated logic circuits.

With VLSI there is even more to learn from manufacturing memory chips. At lower densities, circuits could be economically produced without automated equipment. Indeed, fully 80 percent of the circuits sold by U.S. manufacturers are assembled and tested in Third World countries, usually in low-technology plants using semi-skilled, poorly paid workers. Using such manual techniques and cheap labor once conferred a cost advantage on U.S. firms—albeit one not passed along in great measure to the Third World countries that provided the labor—but with VLSI technology, that advantage will no longer hold.

For example, it will no longer be possible to manually produce or test the next generation of memories—the 256K RAMS. One problem is that they are virtually impossible to make defect-free, so manufacturers make them (like some 64K RAMS) with "redundant," or extra, memory cells. All memory cells must be tested and the defective ones are removed from the circuit. People alone are simply incapable of testing hundreds of millions of cells a day; this will have to be done with highly automated, computer-controlled equipment.

The Optimum Shape



The Optimum Shape

Researchers at the General Motors Research Laboratories have developed the first integrated system for computer design of mechanical parts with minimum mass. Optimal Shape Generation automatically optimizes the component shape in a single computer run.

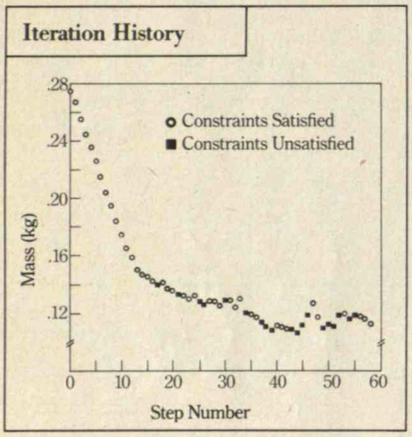


Figure 1: Decreasing mass plotted as a function of design iterations for the component shown in Figure 2.

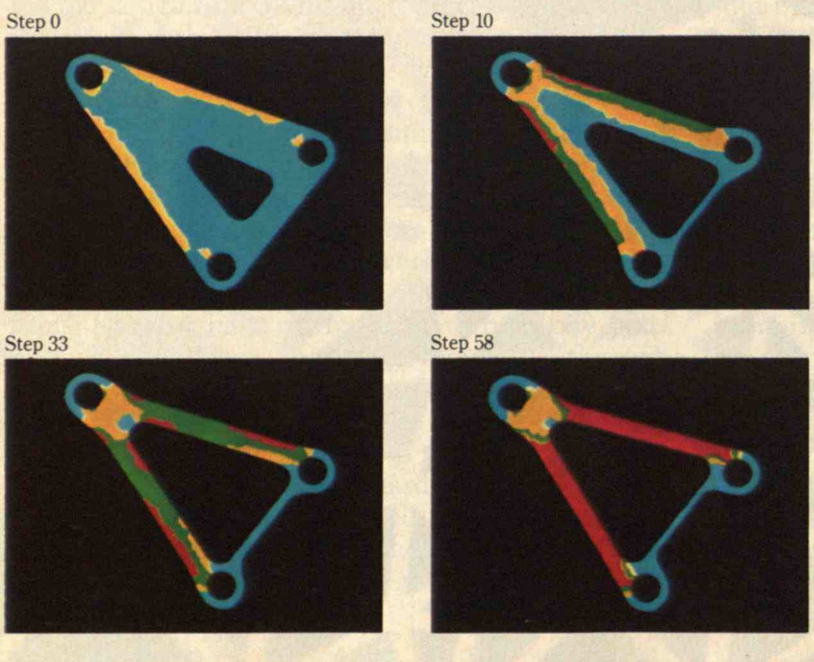
Figure 2: Shapes as they appear on the CRT screen in the design of a minimum mass automotive component capable of performing under the structural loads. Color changes indicate (blue→yellow→green→red) increasing stress levels within the design limits.

COMPUTER-AIDED design systems automate the processes of generating geometric data and engineering drawings of parts, but they do not determine whether these parts meet structural performance requirements. In an ongoing research project at the General Motors Research Laboratories, a system has been developed that automatically ensures that the design meets structural performance constraints. More important, Optimal Shape Generation provides the component shape with the minimum mass capable of satisfying structural demands in a single computer run, without requiring human interaction with the machine.

In the last two decades, extensive research has been done in the area of computer design of structural components. Most of this work has focused on individual aspects of the process. Drs. Jim Bennett and Mark Botkin have succeeded in integrating the process from description of the model through convergence to the optimum solution.

Conventional systems continue distinctions characteristic of age-old "build and test" methods by separating the tasks of design generation and design analysis. Typically, a "designer" uses one computer system to produce engineering drawings of a given part. The task then shifts to an "evaluator" who creates a mathematical model with which to test the design on another computer system. The evaluator determines only whether or not the design meets the requirements. A lengthy interaction between the designer and the evaluator is required to optimize the design. Optimal Shape Generation integrates the process from design generation through design optimization. The system can generate the mathematical model from the design data as the shape changes without requiring additional input, thereby turning the process from a multiperson, multimachine operation into a one-person, one-machine operation.

Since there is no interaction beyond the initial input, a flexible description of the problem is crucial to effective use of the system. The researchers responded to this challenge by developing a geometric format based on a parametric description of the boundary. Defining the problem with geometric data is desirable because it describes the shape of the part in a



form directly suitable for conceptual visualization.

Because the boundary geometric description must be transformed into an analysis model not once but several times, some type of automatic finite element mesh generation is required. The researchers adapted a mesh generation technique which divides a closed region into triangular elements based on a discrete description of the boundary. The sizes of the elements of the mesh are determined by a characteristic length selected for each problem and are related to the need for accurately describing the geometry. Automatic triangulation is used to create a set of connectivities for the discrete points placed uniformly throughout the part's interior with approximately the same density as the boundary points. The combination of boundary data description and automatic mesh generation permits the system to accommodate major changes in shape from the initial design.

ADEQUACY of the triangular meshes to calculate accurate stress levels was next addressed by the development of an adaptive mesh refinement scheme. By evaluating the solution for the uniform mesh created by the choice of characteristic length and identifying areas where the strain energy density changes rapidly, the system selects the areas of the mesh that require mesh refinement. These refinements can take the form of either adding elements in the area to be refined or increasing the order of the finite element polynomial interpolation. The former approach has been taken, because it can be implemented automatically and does not require the formulation of new finite elements.

The culmination of the process introduces an optimization routine which directs the design toward a minimum mass configuration. A mathematical optimization technique is used to change the design to that shape giving minimum mass within the structural constraints. This optimization technique is based upon a sequential first-order Taylor series approximation of the constraints and a feasible directions solution of the problem. Periodic mesh refinements are performed throughout the optimization, since the design is continually changing, and the system must predict the stresses and the behavior of the constraints as the design changes.

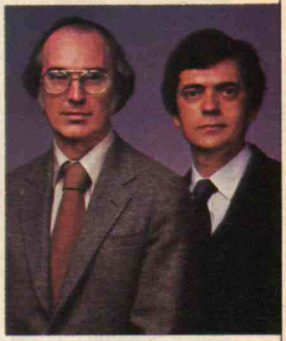
"By taking an integrated approach," says Dr. Bennett, "we're able to combine the objectives of reducing the mass of the material and meeting structural performance requirements in a single automatic system."

"We expect," adds Dr. Botkin, "that in the future this technique will become the standard way of designing structural components."

General Motors

MARK OF EXCELLENCE

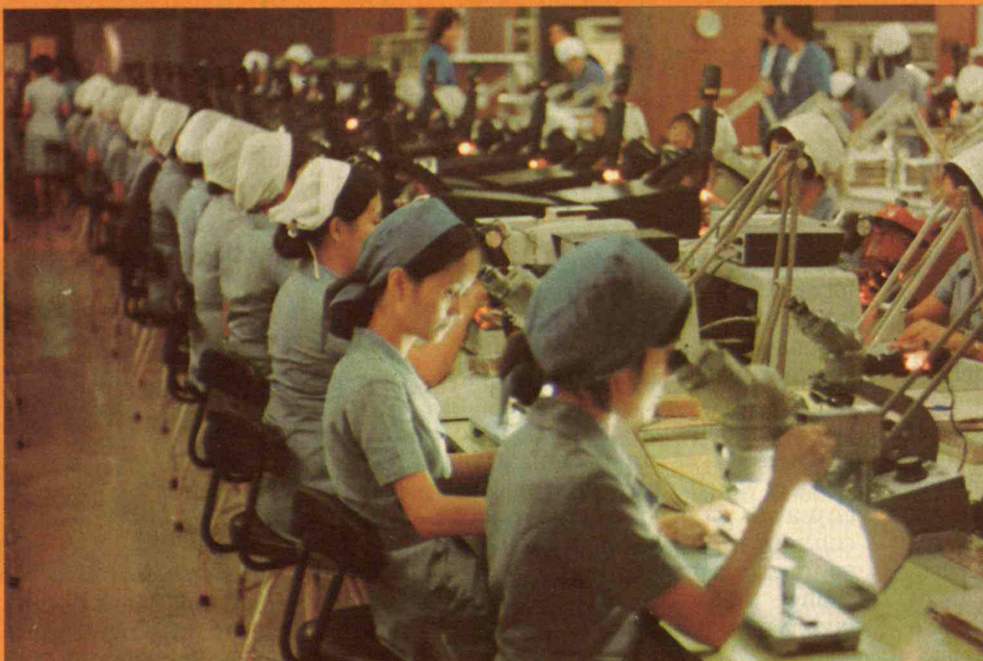
THE MEN BEHIND THE WORK



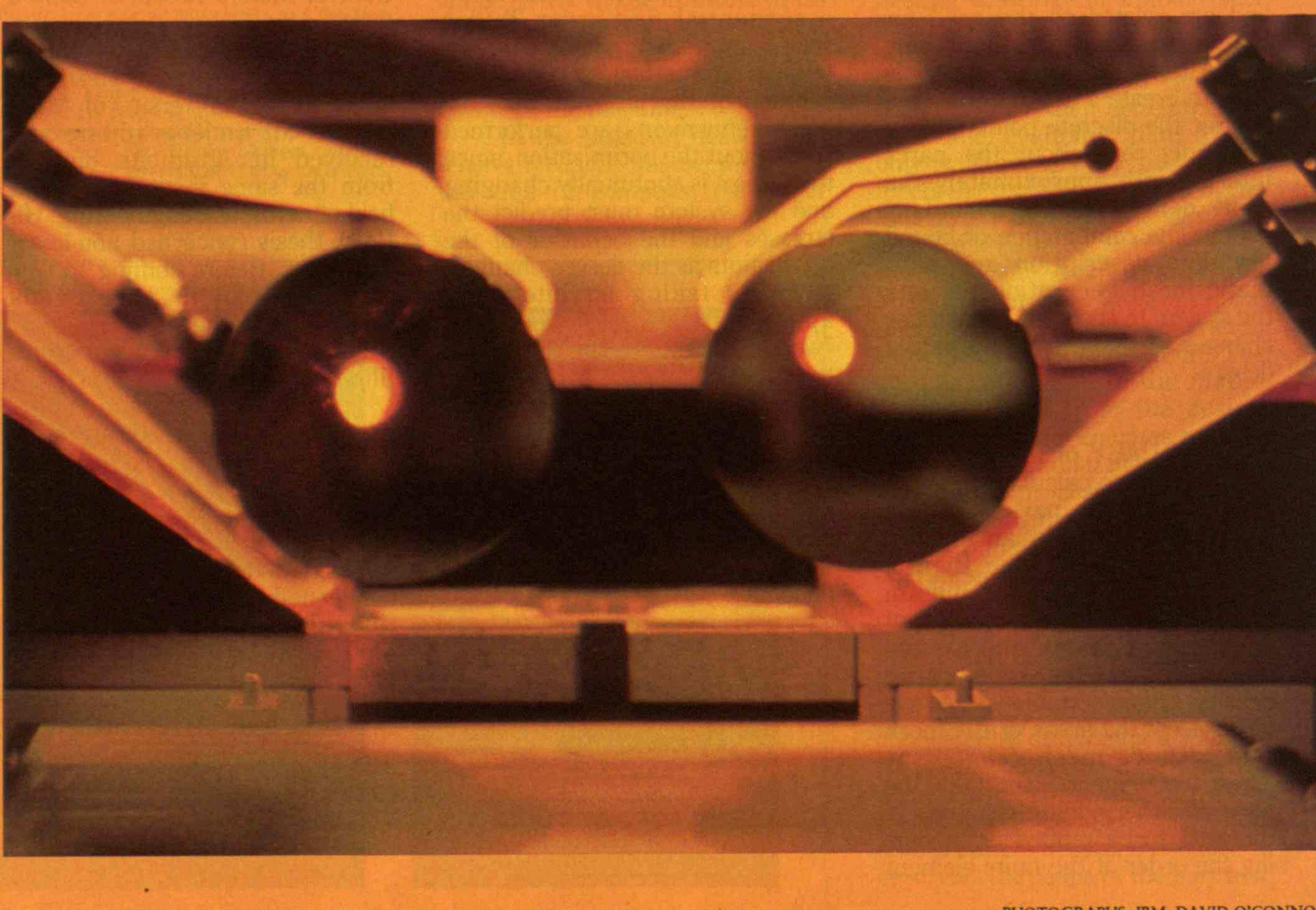
Drs. Jim Bennett and Mark Botkin are members of the Engineering Mechanics Department at the General Motors Research Laboratories.

Dr. Bennett holds the title of Assistant Department Head. He attended the University of Michigan as an undergraduate and received his graduate degrees from the same institution in the field of aerospace engineering. His Ph.D. thesis concerned non-linear vibrations. Before coming to General Motors in 1973, he taught aeronautical and astronautical engineering at the University of Illinois.

Dr. Botkin is a Staff Research Engineer. He received his undergraduate and graduate degrees from the University of Missouri at Rolla. His graduate work was in the field of civil engineering, and his doctoral thesis concerned structural optimization. Prior to joining General Motors in 1978, he worked for four years as a consultant to computer applications engineers.



Very large scale integration, combining hundreds of thousands of transistors on one chip, will require automated manufacturing. For example, the mechanical arms (below) are used to maneuver silicon wafers through one stop in a production line at IBM. However, 80 percent of the chips sold by U.S. manufacturers are still assembled in Third World countries, usually in relatively low-technology plants employing poorly paid workers (left).



PHOTOGRAPHS: IBM, DAVID O'CONNOR

For 25 separate U.S. firms to develop the same generation of memory chips hardly makes sense. A few joint ventures would be more efficient.

Thus, VLSI production will require increasingly automated chip-fabricating equipment, robotized machinery to assemble the chips, and automatic testing devices. Ever more advanced computer-aided design equipment will be needed, primarily for more sophisticated logic chips. U.S. semiconductor merchants are relatively inexperienced with this type of equipment and frequently lack sufficient capital to develop or purchase it. Conversely, U.S. manufacturing equipment producers will need increasingly advanced custom circuits with which they are unfamiliar. Both types of firms will need robotics technologies in which the Japanese are currently world leaders. Finally, advanced computer-aided design systems require both systems expertise and detailed knowledge of semiconductor technologies. World-class systems and microelectronics firms must have expertise in all of these areas—systems design, chip making, programming, and capital equipment—as well as sufficient financing. In most of these areas, the *kieratsu* are in a better position than U.S. merchants.

The Japanese appear to be ahead in automating their semiconductor industry, with the probable exception of computer-aided design systems. Japanese robotics are widely agreed to be the best in the world. Already 90 percent of Japanese circuits are assembled with automated equipment. Japanese purchases of such equipment are increasing rapidly: capital expenditures of the 10 leading semiconductor producers rose 86 percent from 1978 to 1979 and 49 percent from 1979 to 1980, the last year for which statistics are publicly available. Furthermore, the increase has been greatest in the most advanced equipment. By 1980 Japan bought 23 percent of the world's VLSI automatic-test equipment and 32 percent of the world's memory automatic-test equipment. And Japan's share of the world sales of automatic-test equipment for memory chips rose from 18 percent in 1975 to 25 percent in 1980.

To be sure, U.S. manufacturers still purchase and sell over half the world's automatic-test equipment, but their share is declining, especially in advanced sectors. Furthermore, these figures take into account only purchases and sales on the open market, and U.S. firms rely much more on the open market than Japanese firms, which are largely supplied from within their *kieratsu*. Japan's success in the market is increasing, despite the fact that the most advanced production technology is frequently not for sale, and certainly not for export. Thus, Japan's technical strength is even greater than its market share indicates.

Not surprisingly, the Japanese are well ahead in memory-chip markets. By 1978 Japan achieved technical parity with U.S. semiconductor manufacturers in 16K RAMs (a late LSI technology), and Japanese manufacturers captured 40 percent of the world market. By 1982 the Japanese had achieved technical superiority in manufacturing memory chips and captured 70 percent of the world market for 64K RAMs, an early VLSI technology. That year they increased their open-market semiconductor sales by 25 percent, while U.S. sales declined by 5 percent. Texas Instruments responded by transferring its memory-production operations to Japan; Intel ceased production of 64K RAMs completely.

The next generation of memories, the 256K RAMs, will be out in 1984, and the Japanese are expected to dominate the market. As mentioned, four Japanese companies already have prototypes, and two others will have them soon. In the United States, only Western Electric and Motorola are reportedly in the running. And regardless of the outcome of the 256K RAM competition, Japanese dominance of 64K memory markets has already reduced economies of scale and manufacturing experience in the U.S. industry.

So far Japanese penetration of world markets has been restricted to commodity circuits that do not require advanced computer-aided design—particularly RAMs—but this is a very large market. Furthermore, there is every reason to believe the Japanese will try to build on their manufacturing experience to sell more sophisticated chips. They have already entered other growing markets, particularly for 16-bit microprocessors, logic circuits of intermediate capability, and gate arrays, mass-produced chips that can be customized at the end of the manufacturing process.

In late 1981, a large U.S. systems firm estimated that Japan possessed a two-to-four year advantage in so-called "CMOS" circuits at VLSI densities. CMOS is one of several technologies available for making integrated circuits; CMOS circuits consume little power and produce little heat. Cooling computers is expensive: mainframes are often fancily packaged and water-cooled, while supercomputers must be cooled by liquid nitrogen. Since CMOS circuits can be air cooled, they are particularly well suited to inexpensive microelectronics applications. The Japanese lead in CMOS appears to be especially strong in two areas:

Automated equipment for diffusion techniques (right) is used to alter the electrical characteristics of chips.

32-bit microprocessors used in micromainframes and 64K "static" RAMs—memories that, unlike simpler "dynamic" RAMs, retain information even without a power supply. Indeed, the Japanese are expected to dominate the 64K static RAM market within about a year.

The Advantage of Planning

Japan has succeeded in microelectronics because it planned to do so and acted accordingly. The Japanese industry started from behind, producing unsophisticated devices for the consumer electronics market. Ten years ago, Japan exported only modest quantities of semiconductors, mainly to other Asian nations. But government protectionism, combined with Japan's overall economic growth, created sizable domestic markets. The growing importance of microelectronics in computer systems, and industrial performance generally, led the Japanese to initiate ambitious research, development, and investment programs.

In the mid-seventies, the government, along with the *kieratsu*, began preparing for VLSI. Beginning in 1976, the Ministry of International Trade and Industry (MITI) sponsored research and development on VLSI technology to be shared by major Japanese semiconductor firms. Systems and electronics firms such as Fujitsu, Hitachi, and NEC invested heavily and entered foreign LSI markets for the first time. As they began manufacturing LSI circuits such as 16K RAMs, they undertook major VLSI research and development programs. The Ministry of Finance (MOF) encouraged lending to VLSI manufacturers; MITI provided direct financing and coordination.

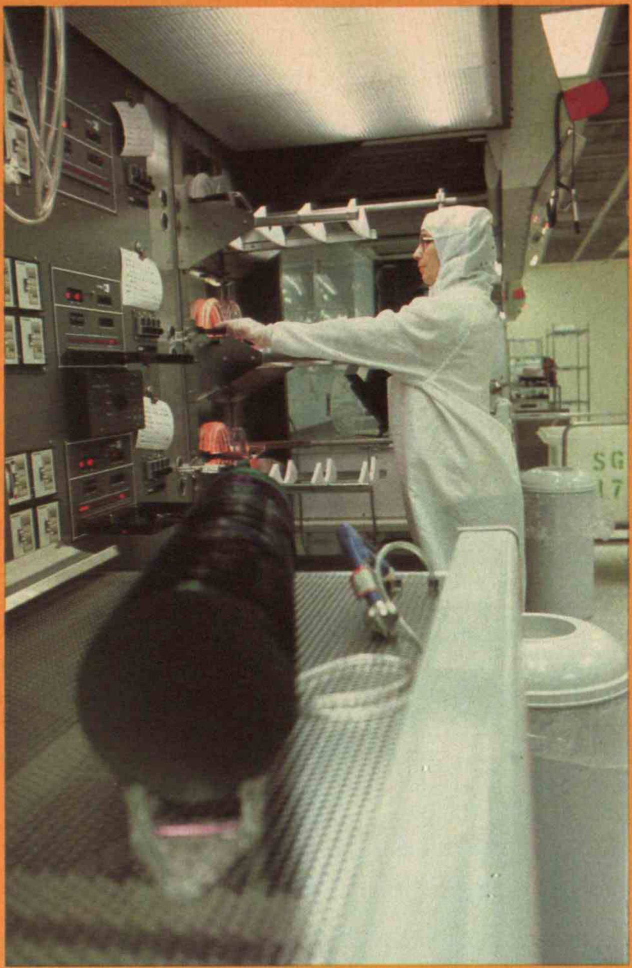
Nippon Telephone and Telegraph (NTT), the Japanese counterpart of AT&T, also contributed to the effort. Beginning in the late seventies, NTT made a strategic decision to provide digital communications services for improved computer communications and to give Japanese semiconductor manufacturers a market for VLSI circuits. NTT's usual procedure is to perform research itself, share its results with several manufacturers, and contract out production. AT&T, by contrast, does not allow other U.S. semiconductor firms to use its technology—indeed Bell has refused merchant semiconductor manufacturers access to its computer-aided design systems.

Already coordinating efforts to excell in coming technologies, major Japanese systems firms and the government have launched the Fifth Generation Computer Project. While its announced goals are probably overly ambitious, the effort is serious and may give Japan world leadership in future high-performance computers. The immediate goals are twofold. First, supercomputers based on Josephson junction circuits, which more rapidly perform the same functions that ordinary integrated circuits do, may be extremely fast machines, though it appears that they will have conventional "architectures," or logic designs. Second, "data-flow" machines may prove able to efficiently employ tens or even thousands of processors. (So far, no one has figured out how to do this, but if it becomes possible, tremendous power can be achieved extremely cheaply.) Japan has also begun large-scale work on software, especially artificial intelligence.

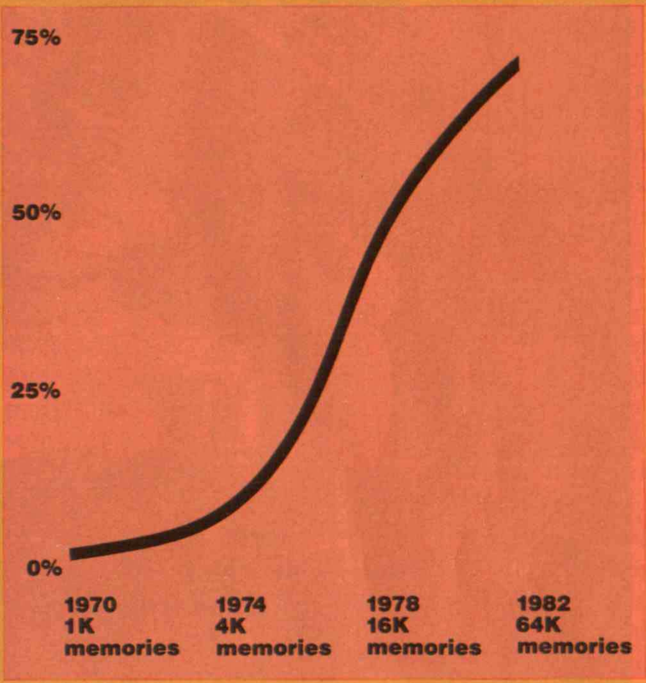
While government guidance has aided the Japanese industry, the once comparable force to abet electronics research and development in the United States—the military—has become a negative factor. Military purchasing helped the microelectronics industry during the sixties, because when civilian markets were small the military was obliged to finance substantial basic research and development to produce the semiconductors it needed. However, during the seventies, not only did the military become a much smaller share of the market, but the basic computational power it needed was more widely available. It mainly had to pay for its specialized needs, such as chips more resistant to radiation and temperature extremes. Although the Defense Advanced Research Projects Agency finances some basic VLSI research, a large fraction of military-sponsored research directly on semiconductor circuitry is commercially useless.

Consider the Very High Speed Integrated Circuit (VHSIC) program, through which the Defense Department is allocating $40 million a year to develop advanced semiconductors for military applications. Such circuits typically have very different requirements from those of most commercial applications. For example, many military circuits employ CMOS technology, but require sapphire backings for additional speed. Such circuits cost too much for widespread commercial use. The firms doing this VHSIC research are defense contractors; commercial semiconductor manufacturers could benefit little from the program.

U.S. microelectronics has also been damaged by the



In 1970 the Japanese had virtually none of the world market for 1K random-access memories (RAMs)—chips that store about 1,000 pieces of information in computers. Owing largely to highly automated production, by 1982 the Japanese had captured 70 percent of the world market for more advanced 64K RAMs. Well-tuned production facilities will help in manufacturing more sophisticated logic chips.

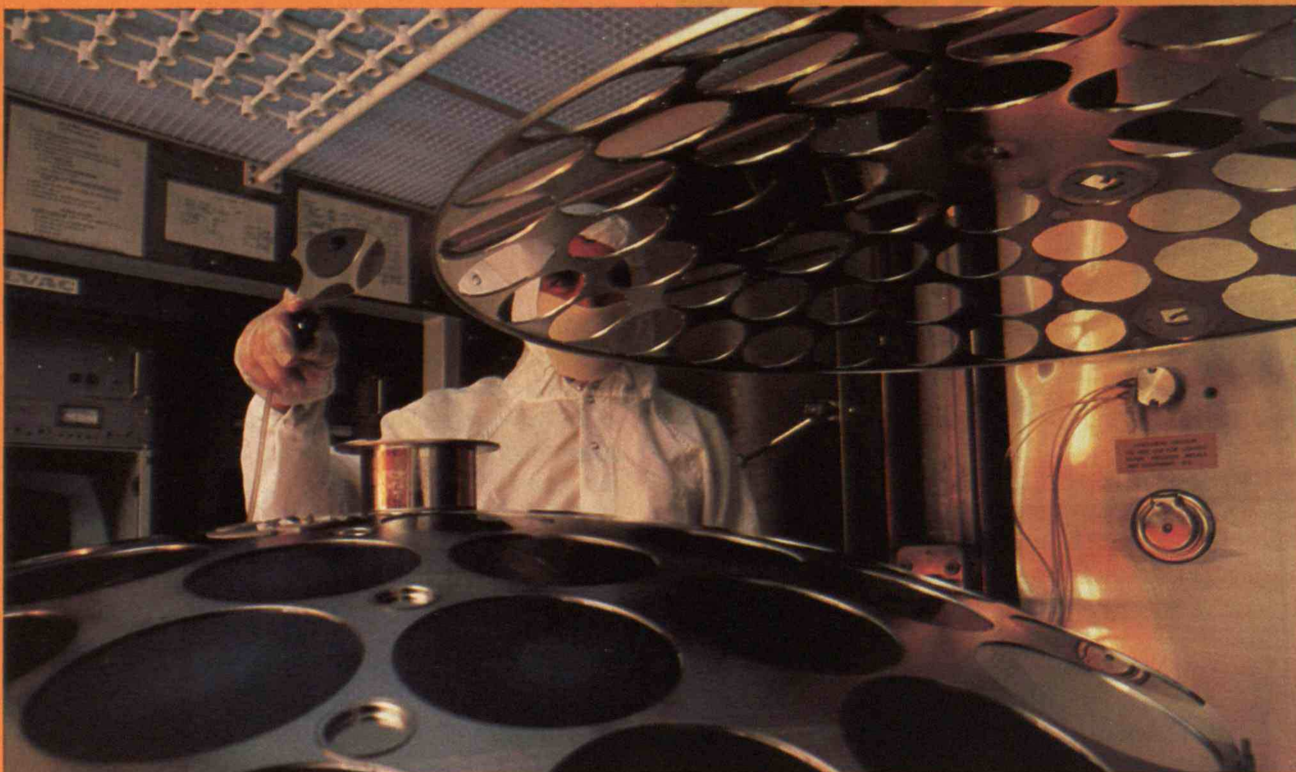


division between semiconductor and systems firms. One might expect IBM to possess the same strengths as the Japanese *kieratsu* and therefore to be able to bolster the position of U.S. microelectronics, but the matter is not so clear. Unlike the Japanese *kieratsu*, IBM is alone in the U.S. industry—more than eight times the size of its nearest competitor. As already noted, it has been biased toward conservative technologies, principally commercial general-purpose mainframes. And by producing its most advanced circuits itself but purchasing relatively outdated circuits from merchant firms, IBM has tended to reduce the technical sophistication and financial stability of open-market semiconductor manufacturers. IBM itself produces the complex microelectronic circuits and packaging most critical for its mainframe computers. By contrast, memory chips are important mainly because they are needed in large numbers. IBM produces a minimum of these and makes irregular purchases on the open market to meet peaks in demand.

Several systems firms are clearly interested in increasing their semiconductor capacity so they can make the full spectrum of choices and trade-offs available to IBM and the large Japanese companies. Digital Equipment Corp. (DEC) and several others have substantial computer-aided VLSI design programs underway. Hewlett-Packard has developed some advanced production equipment and is making its 32-bit microprocessor for the HP 9000. Honeywell owns a semiconductor firm, Synertek, with which it has recently undertaken substantial joint efforts. And the Microelectronics and Computer Technology Corp. (MCC) research collaborative includes both systems and semiconductor firms.

Nonetheless, the future of the major systems firms other than IBM is not bright. Their recent financial performance has been poor. None possesses semiconductor-production operations more than one-twentieth the size of IBM's, and they generally lack the capital and expertise to start making VLSI devices on an efficient scale. Moreover, there are few likely semiconductor firms for them to buy. Fairchild has already been purchased by Schlumberger, a diversified French firm; Exxon owns Zilog; IBM has in effect staked a claim on Intel. Motorola and National Semiconductor remain independent, but they are basically too big for systems firms other than IBM to buy. Texas Instruments, which will lose hundreds of millions of dollars this year, can already be counted a

Computerized metal-evaporation equipment deposits a thin layer of metal onto the chip, which is later etched to define the complicated circuitry.



victim of the VLSI revolution.

Furthermore, systems firms are wary of depending on independent semiconductor merchants for custom circuits critical to their systems. The chip maker's interest lies in its spectrum of customers, and no individual systems firm can assume it is the most important. Systems firms concerned about disclosing proprietary information prefer to design and produce their own chips. (Indeed, the security issue may significantly reduce Japanese penetration of U.S. custom logic markets: several Japanese firms are widely and correctly regarded as unacceptable security risks by domestic systems firms.)

Thus, systems firms in need of a custom chip generally have two choices. They can make the chip themselves in relatively inefficient facilities or simply forego the ideal custom design and use standard commercial chips.

For their part, U.S. semiconductor firms lack the financial resources for adequate research, development, and investment. Part of the problem is that the cost of capital equipment has been rising precipitously. Ten years ago a semiconductor factory could be set up for $1 million: today that price buys only one electron-beam etching machine, and a state-of-the-art fabrication plant costs $20 million or more. Through their *kieratsu*, the Japanese semiconductor firms have access to the requisite amounts of capital at relatively stable, low interest rates. U.S. interest rates are higher and less predictable. Furthermore, although U.S. semiconductor merchants grew quite large during the seventies, their profits have been squeezed by the Japanese, so that today they have difficulty securing capital to invest at the requisite scale. And U.S. producers of semiconductor manufacturing equipment are in a similar plight.

The Need for Government Assistance

Current U.S. efforts to cope with the VLSI revolution are inadequate. A number of universities—principally M.I.T., Stanford, Berkeley, Carnegie-Mellon, Cornell, Caltech, and North Carolina—have research programs in VLSI systems financed by government and industry. These are of high quality but have not been adequately financed.

The Semiconductor Research Cooperative, a facility established primarily by semiconductor firms, plans to spend several million dollars a year on research—far below what is necessary for competi-

World-class firms must have expertise in making chips, designing computer systems, and programming.

tive success. MCC, a larger research collaborative including both systems and semiconductor firms (but not IBM), will have a budget of $50 million per year, but its results will be available only to members, and it has yet to begin operations.

A systematic effort is required to understand and act upon the enormous implications of VLSI technology for the future of the U.S. economy. Policies for the microelectronics industry must be coordinated by the government yet avoid the rigidity often introduced by bureaucracy. A small executive agency, representing all segments of the industry, universities, and labor, could be responsible for overall planning and allocating money. But detailed implementation should be carried out in a decentralized fashion by other government agencies, the educational system, and the private sector.

The following broad measures are clearly necessary:

□ The cost of efficient manufacturing operations appears to double every three to five years, and the industry's own resources will probably prove inadequate to meet these costs. The government should provide tax incentives for research and capital spending and should stimulate demand for advanced products—through purchasing for its own offices, for example.

□ Research and development for advanced microelectronics—apart from military technology—in universities, government laboratories, and industry needs additional financing. The government should award grants of perhaps $10 million a year to each of 20 or 25 universities and laboratories to strengthen existing microelectronics research groups and establish new ones. The government should also consider establishing national microelectronics laboratories that could pursue long-term research unattractive to other groups because of costs or uncertainty.

□ The government should encourage more joint ventures among companies—not just for basic research, as MCC is doing, but for product development. For 25 separate firms to develop the same generation of memory chips is hardly efficient. A few joint ventures, each composed of a number of individual companies, would achieve the same results more effectively and with less total cost.

U.S. antitrust law poses a difficulty not encountered by Japanese firms, which routinely enter such joint research and development ventures. The Justice Department has liberalized regulations for joint ventures somewhat, but this effort should be carried further. For example, enterprises should be given unambiguous information at the start as to whether a joint venture is legal. In some cases, the government should promote these ventures by giving them research and development grants. To ensure that the entire industry benefits, the government might require the group to license technology to other firms.

□ Government must also assist in regulation and standardization. Today one manufacturer's products frequently cannot "talk" with another's. This menagerie of incompatible equipment wastes efforts and curtails competition: once a customer has bought one manufacturer's system, adding another company's products is hard. Establishing joint research ventures would be a good start toward making electronic products compatible, but the government should also set standards—not an easy task.

□ Education requires direct government attention. While universities in nations such as Japan and Germany are graduating increasing numbers of electrical engineers, the United States has a notorious shortfall. The government must provide substantial financial support for faculty and students working on microelectronics theory, technology, and policy.

□ At the same time that there is a shortage of engineers, many blue-collar and clerical employees are losing their jobs. The government must address this tremendous waste of human resources. Clerical and industrial workers whose jobs are automated will require employment security and retraining. The government should also increase financial support for electronics-related career training in secondary schools and colleges.

These measures will not come easily. The field of microelectronics is complex, and the United States has little experience in implementing a coherent technology policy comparable to that of MITI. Powerful groups such as the Department of Defense may find their interests threatened and therefore lobby against an effective policy; even commercial firms may balk at incurring the costs of fundamental change. But the economy will suffer if the United States does not make a serious attempt to confront these problems. VLSI is here to stay.

CHARLES H. FERGUSON is a software analyst at IBM, but the views expressed here are his own. He performed the research for this article while a graduate student in political science at M.I.T. through the Program in Science, Technology, and Society.

The U.S. command-and-control network is more vulnerable than the forces it controls. Making the systems on both sides more survivable would increase the stability of the strategic balance.

Strategic Command and Control: America's Achilles Heel?

BY JONATHAN B. TUCKER

On October 2, 1981, President Reagan told the American people what military analysts had known for some time: in spite of the great concern in recent years over the vulnerability of U.S. land-based ballistic missiles, there is a much more tenuous component of the U.S. strategic arsenal. This weak link is the system of command, control, communications, and intelligence (C^3I) through which the national civilian and military leadership would detect a Soviet attack and direct a response. C^3I facilities are inherently more vulnerable to the effects of nuclear weapons than the strategic forces they control. And as former Deputy Secretary of Defense Frank Carlucci pointed out, "It does us little good to have a strategic deterrent if, after a first strike, we can't communicate with it."

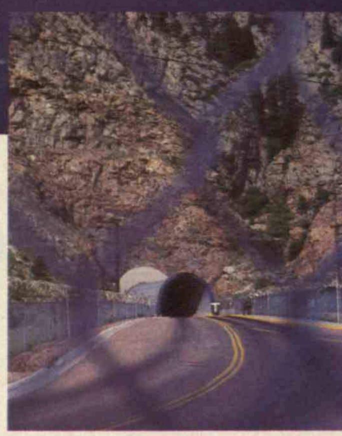
President Reagan has proposed spending some $38 billion through fiscal year 1984 on modernizing the C^3I system—the number-one priority among the administration's strategic programs. So far the White House has been getting its way. Although Congress has questioned the need for new offensive weapons such as the MX missile and the B-1 bomber, it has actually exceeded the president's funding requests for upgrading C^3I. Nevertheless, the administration's plans deserve careful scrutiny, as does its nuclear strategy, which determines what kinds of C^3I capabilities are necessary.

The U.S. C^3I system, known as the World-Wide Military Command and Control System (WWMCCS, pronounced "wimex"), is a vast network of command posts, data-processing centers, communications links, and satellites. The "national command authorities"—the president, secretary of defense, and chairman of the joint chiefs of staff—and their subordinates use this network to direct all aspects of the U.S. armed forces. Through WWMCCS, they control the widely dispersed elements of the U.S. nuclear arsenal: a "triad" of 1,054 intercontinental ballistic missiles, 376 strategic bombers, and 32 missile submarines, plus thousands of tactical and intermediate-range nuclear weapons deployed in Europe and the Pacific.

C^3I installations would be priority targets in a nuclear war, primarily because they are "force multipliers." That is, they make it possible to deliver warheads to military targets in complex attack patterns with great precision, increasing their effectiveness and making them better able to penetrate enemy defenses. For example, the computerized Command Data Buffer System, based with the Minuteman-3 ICBM force, allows U.S. Air Force programmers to

As part of the U.S. nuclear arsenal, B-52 bombers are always on "strip alert" at the Strategic Air Command (SAC) base near Omaha, Neb.

PHOTO: HERMAN KOKOJAN, BLACK STAR



change the target coordinates of these missiles in 25 minutes. Thus, the entire force of 550 Minuteman-3 missiles can be retargeted in less than ten hours—a task that used to take weeks—permitting much greater flexibility.

The force-multiplier role of C^3I is particularly important today, when there is rough numerical equivalence between the arsenals of the superpowers. This parity means that how effectively the weapons can be used has become a major factor in the strategic balance. Therefore, in the event of war, each side would have a strong incentive to damage or confuse the other's C^3I system as much as possible—either through direct nuclear attack, sabotage, jamming radio links, or "spoofing" (broadcasting misleading messages). Even if C^3I systems were not attacked directly—perhaps to maintain the means for leaders to terminate the war short of mutual devastation—many crucial facilities would still be damaged by the effects of nuclear explosions directed at other military targets.

Making C^3I systems on both sides more survivable would increase the stability of the strategic balance. Neither side would be as tempted to strike first in a crisis—either in the hope of disarming the opponent or for fear of being disarmed. The conviction that C^3I could endure a first strike would also reduce the pressure to launch nuclear weapons in response to an early computer warning of an attack. Since all electronic systems are fallible, a launch-on-warning policy would greatly increase the risk of accidental nuclear war. As Charles A. Zraket, executive vice-president of Mitre Corp. and a consultant to the Department of Defense on C^3I, explains, "What we need is a safe, assured capability to ride out a limited attack and then have time to make a rational and proportionate response. If we didn't have that, our only alternative would be to adopt a launch-on-warning posture and respond to any attack with all-out retaliation."

The Carter administration was the first to initiate programs to make C^3I systems more capable of

PHOTOS: HERMAN KOKOJAN, BLACK STAR

The craggy granite of Cheyenne Mountain, near Colorado Springs, shields the North American Aerospace Defense Command headquarters. This tunnel leads to 25-ton blast doors at the entrance to the inner complex housed in steel buildings.

Information from global satellite and radar systems streams constantly into NORAD's command post (center), space computational center, and missile warning center (right), where more than 1,500 people are aided by nearly 100 computers. From here the first warning of an attack would be flashed to government and military leaders so they could alert strategic forces for action.

However, even NORAD could not survive a direct hit by a nuclear warhead. Thus, the government has other command centers, both airborne and on the ground, to ensure "survivability" of the command-and-control network.

enduring a surprise attack. The Reagan administration has expanded this effort, but some of its new proposals reflect a subtle but significant change in overall strategy. While the Carter administration focused on developing C^3I systems that would guarantee a fairly massive retaliatory blow as a deterrent to nuclear war, the Reagan planners seek to develop more sophisticated C^3I systems that would remain operational through a series of limited nuclear exchanges over weeks or even months.

This switch to a war-fighting strategy that includes controlled escalation has greatly increased the complexity and scope of the C^3I mission. Thus, it is important to distinguish between the basic need to ensure a second-strike capability to deter nuclear war, and the much more ambitious plans for the capability to actually conduct a protracted but limited war. Although the Reagan administration is pursuing these two objectives simultaneously, the former has strong priority, while the protracted-war strategy remains a long-term but actively pursued goal.

Sources of C^3I Vulnerability

C^3I systems are vulnerable to both the direct and indirect effects of nuclear weapons. Not only are radars, radio transmitters, telephone lines, and switching centers large and relatively "soft" fixed sites that are easy to target, but they can also be disrupted by nuclear weapons exploding tens, hundreds, and even thousands of miles distant. For example, ground bursts inject vast quantities of dust and debris into the atmosphere—akin to the giant dust clouds spewed out by the erupting Mount St. Helens—that distort or weaken radio waves. Atmospheric explosions dramatically increase the density of positive ions in the ionosphere (the layer of the upper atmosphere that reflects radio waves), blacking out long-distance high-frequency and ultra-high-frequency communications for several hours. And atmospheric explosions emit vast numbers of free electrons that cluster along the earth's magnetic-field lines, creating an effect known as "scintillation" that interferes with

the propagation of many radio frequencies.

Nuclear explosions high in the atmosphere also generate an electromagnetic pulse (EMP)—a brief but violent electrical discharge that can burn out sensitive electrical or electronic circuits. A surprise EMP attack could be achieved by exploding a nuclear weapon concealed in an orbiting satellite or by launching "enhanced-EMP" weapons from submarines stationed just outside U.S. (or Soviet) territorial waters. Communications systems are particularly sensitive to EMP because they are usually connected to electrical conductors such as cables, antennas, transmission towers, and metallic aircraft. A single nuclear warhead exploded 200 miles above the earth's surface would knock out all unshielded electrical and electronic equipment (including telephone and power lines) for 1,000 miles in every direction. Defense planners therefore fear that a series of EMP weapons exploded high over the United States could shut down the national power grid for hours or even days, incapacitating large segments of the military C^3I network.

The "hardness" of an electrical or electronic circuit—its resistance to the sudden voltage surge generated by EMP—is greatest for vacuum tubes, much less for semiconductors, and still less for integrated circuits. Specifically, vacuum tubes have 10 million times more hardness against EMP than integrated circuits. Thus, although microelectronics are lighter, compute faster, and use less power, their widespread use in communications systems has greatly increased the systems' vulnerability to EMP. This weakness applies to Soviet systems as well. Although Soviet military electronics are more primitive and hence somewhat more resistant to EMP, most analysts conclude that the vulnerability of C^3I to nuclear effects is roughly equivalent on both sides.

Satellites are also vulnerable to EMP, which can erase their electronic memories and damage integrated circuits. This vulnerability is important because both superpowers depend heavily on satellites for photo-reconnaissance, communications, navigation, weather forecasting, and early warning of nuclear attack. Indeed, the U.S. military routes 70 percent of its messages through satellites and the Soviets roughly 60 percent.

Satellites are at risk from another indirect effect of nuclear explosions as well: intense exposure to ionizing radiation such as x-rays, gamma rays, and fast neutrons. Ionizing radiation can damage electronic

PHOTO: HERMAN KOKOJAN, BLACK STAR

In a nuclear attack, the president will be evacuated to the National Emergency Airborne Command Post. This plane is crammed with communications gear and is hardened against the effects of nuclear blasts.
An aide accompanies the president wherever he goes, carrying the "football," a black bag reportedly containing the codes needed to order a retaliatory strike.

circuits through "TREE" effects (transient radiation effects on electronics), such as altering the operating characteristics of transistors or disrupting the crystal lattice structure of semiconductors. A single one-megaton warhead exploded in space would saturate with high-energy particles a spherical zone with a radius of about 1,000 kilometers. Some of the charged particles produced by nuclear explosions would also be trapped by the earth's magnetic field, creating a long-lived radiation belt that could damage even those satellites not directly exposed to the blast.

Another growing concern is that satellites may soon become vulnerable to antisatellite weapons unless this technology is constrained through arms-control negotiations. Both the United States and the Soviet Union have active programs to develop antisatellite weapons. In 1977, the Soviets tested a "hunter-killer" satellite capable of destroying reconnaissance satellites in low-earth orbit. The United States has developed but not yet deployed a more sophisticated antisatellite device: the "homing interceptor technology" (HIT) weapon—a direct-ascent, nonnuclear projectile that will ram its delicate target. Both sides are also working on directed-energy weapons (lasers and particle beams) that could destroy satellites, as well as techniques for reducing satellite performance through jamming or deceptive "spoofing."

Delivering the "Go-Code"

A combination of satellites and radar installations would provide early warning of a Soviet nuclear attack. Evidence of an imminent attack might be obtained weeks or days in advance from photo-reconnaissance satellites that can detect changes in the deployment and alert status of Soviet strategic forces. However, warning of an actual attack would be given by early-warning satellites in very high stationary orbits over potentially threatening parts of the world. Constantly scanning the earth's surface with infrared sensors, these satellites would spot the fiery exhaust of Soviet missiles within two minutes of launch and transmit the warning to the North American Aerospace Defense Command (NORAD) near Colorado Springs, as well as other national command centers. Ground-based radar installations would confirm the attack and track the incoming warheads. These installations include the Ballistic-Missile Early Warning System (BMEWS) in Alaska, Greenland, and northern England; the COBRA DANE radar in the Aleutian Islands; and the ABM radar in Concrete, N.D. Submarine-launched ballistic missiles would be detected by the PAVE PAWS radars operating in Massachusetts, Florida, and California.

The primary function of the C^3I system during peacetime is to maintain "positive control" over all nuclear weapons so that unauthorized or accidental use does not occur. Thus, even in the face of a suspected attack, there are a number of elaborate "fail-safe" mechanisms. One such precaution, known as the "permissive action link" (PAL) program, prevents nuclear weapons from being armed until the president authorizes the release of a special numerical code known as the "emergency action message," or go-code. Without this code, nuclear missiles cannot be launched and strategic bombers cannot arm their weapons or proceed to target. A second precaution, known as the "two-man rule," ensures that nuclear weapons can be launched only by the joint action—within a few seconds—of at least two individuals sitting at widely spaced consoles.

Until an attack is confirmed and the president decides how to respond, positive control remains in effect. Even so, at the earliest warning, the B-52 and FB-111 strategic bombers on "strip alert" would scramble into the air to avoid being destroyed on the ground. Each bomber would then fly a predetermined distance toward its target and circle well outside enemy territory, waiting to receive the go-code. Once the radio message was received and authenticated, nuclear weapons on board could be armed by a joint action of several members of the crew. But without the go-code, no further action could be taken.

Because of the nature of positive control, an adversary planning a first strike would have a strong incentive to destroy, jam, or spoof the U.S. C^3I system to prevent the go-code from reaching the strategic forces. To ensure that the signal could be delivered, the national command authorities have access to 43 different communications systems, including priority and commercial telephone, teletype, microwave relays, and radio transmitters ranging across the electromagnetic spectrum. All these systems are somewhat vulnerable to direct attack, sabotage, jamming, nuclear blackout, and EMP, although they have different strengths and weaknesses.

The most survivable communications channels are provided by the Minimum Essential Emergency Communications Network (MEECN). This crucial

PHOTO: ERIK SIMONSEN, BLACK STAR

This radar station in Greenland is part of the Ballistic Missile Early Warning System. First warning would come from satellites that can spot a missile's exhaust within 2 minutes of launch. Ground radars would confirm the attack and track incoming missiles.

core of the C³I system includes two-way teletype communications with the Strategic Air Command (SAC) missile and bomber forces, and special channels on military satellites. A major focus of the C³I modernization program involves upgrading the MEECN channels and "hardening" them against nuclear effects. The goal is for these systems to be able to withstand EMPs of 50 kilovolts per meter (the maximum expected from high-altitude nuclear bursts) and 10,000 rads of radiation—well above the dose that would kill or incapacitate humans.

There are three complementary approaches to hardening communications hardware. First, large systems such as computers or telephone exchanges can be shielded from EMP by encasing them in screened steel shelters known as Faraday cages, or by locating the facilities deep underground. Second, conductors that pick up EMP, such as cables or antennas, can be isolated from sensitive equipment by means of "surge arrestors"—filters similar to those used to protect against lightning but designed for the much faster current rise-time of EMP. Third, electronic circuits can be made more resistant to EMP and TREE effects, and metal cables can be replaced with fiber-optic transmission lines that do not pick up EMP. Indeed, plans for upgrading SAC's teletype links involve extensive use of fiber optics, as do the communications systems for the MX missile and the B-1 bomber.

Cost is a major constraint. Shielding a new facility against EMP adds about 20 percent to the price, and retrofitting an old one is considerably more expensive. Because EMP hardening is too expensive for entire power or communications grids, the only alternative is to shield a few high-priority facilities. Unfortunately, such measures increase the incentive for an enemy to make a direct attack on hardened stations.

It is also difficult for designers to know whether their hardened systems will perform reliably during nuclear war. Because the damaging effects of EMP and radiation on electronics were recognized just prior to the signing of the Partial Test-Ban Treaty of 1963, which prohibited nuclear testing in the atmosphere or in space, information on these effects is limited. Although large EMP simulators have been built, it is not known how closely they imitate the effects of a thermonuclear blast. Moreover, the EMP hardness of electronic components has been found to vary widely depending on the manufacturer, so circuits made of components of different makes would not be equally survivable.

Backup Communications

Because of the inherent vulnerability of MEECN facilities such as teletype lines and satellite ground stations, the air force plans to build a backup network to ensure two-way contact with SAC missile sites and airbases. Called the Ground Wave Emergency Network (GWEN), this system will consist of roughly 50 relay stations with 300-foot transmission towers scattered around the country. Each station will transmit very-low-frequency (VLF) radio signals that will travel for a few hundred miles along the ground to adjacent stations. Unlike conventional radio waves, ground waves are nearly impossible to jam and are not as disrupted by atmospheric disturbances caused by nuclear blasts.

The individual GWEN relay stations will be located far enough apart so that the Soviets would have to target each one separately, and the stations will be shielded against EMP by Faraday cages and hardened circuits. In addition, the entire GWEN network will utilize a communications technology known as "packet switching," in which the message is digitized and divided into a number of "packets." Microprocessors will shunt the packets through the network along many alternate routes, and at their destination a computer will reassemble the packets to obtain the original message. Thus, a large number of GWEN relay stations could be destroyed without disrupting message flow through the network, since a path could still be found through the surviving stations.

Of all the officially announced C³I programs in the Reagan package, GWEN is one of the clearest examples of a communications network designed to endure in a protracted nuclear war. Because it is a highly redundant system, it might survive a series of limited nuclear strikes over a period of weeks or months. The Pentagon plans eventually to increase the number of relay stations from 50 to a few hundred, which will further discourage the Soviets from attacking because they would be forced to commit an unacceptably large number of warheads to disable the system.

The United States is also strengthening its satellite systems. The major satellites now used for C³I are those of the Defense Satellite Communications System (DSCS). (A few channels on other military satellites are also used for C³I—including the navy's Fleet Satellite Communications System—but these have other primary missions or are limited in their geo-

PHOTO: U.S. AIR FORCE

MIT

A total of 1,613 students received 1,754 degrees as some 6,000 guests observed M.I.T.'s 117th commencement exercises. Pelted by intermittent rain and chilled by the surprisingly raw cold for May 27, everyone retained a mood of joy and celebration.

Graduation photos: Frank Siteman, 1983.

FOR GRADUATES, "AFTER M.I.T." IS NOW

by Marjorie Lyon

"As we turn our brass rats around and head into the real world . . ."

The event is planned for a very long time, marking the horizon as a landmark, a time of transition, a rite of passage from youth to adulthood. The actual time in which it happens passes quickly, but its meaning and memories linger. Faces and gestures are frozen for eternity in a myriad of photos: graduation.

It is May 27, 1983. Cameras are everywhere, their lenses catching a mood of celebration hardly dampened by the raw grey chill and intermittent rain. Boston's gloom produces a colorful array of umbrellas and raincoats. The angry sky doesn't change the decision, made by committee of four at 6:00 a.m., to hold the ceremony in Killian Court. "That's where commencement *is*," says Mary Morrissey, the executive secretary of the Commencement Committeee, with finality.

At 9:45 a.m. pomp and circumstance once again grace M.I.T.'s grand court. The academic procession begins and a long stately line of black-robed figures moves slowly down the center isle: dignitaries, members of the faculty, and graduates. A brass ensemble is conducted by Herbert Philpott, and the John Oliver Chorale performs during the procession, beginning with "Killian Fanfare," written for the occasion by one of the graduates, Hilton C. Russell, '83.

Undergraduates number 820 and graduate students, 973, totalling 1,613 to receive 1,754 degrees. Some 6,000 guests observe M.I.T.'s 117th commencement exercises. For the first time in M.I.T. history, over 20 percent of the degrees are awarded to women. And someone in the mass of graduates receives the 100,000th degree. President Gray poses what he calls the last problem set: figure out who that person will be. (It is not an easy task, complicated by the fact that some students receive more than one degree and the lineup changes until the last minute.) Those who take President Gray up on it begin a count, starting with 99,500 (the approximate number of degrees awarded in the years since 1868). But results remain indefinite . . .

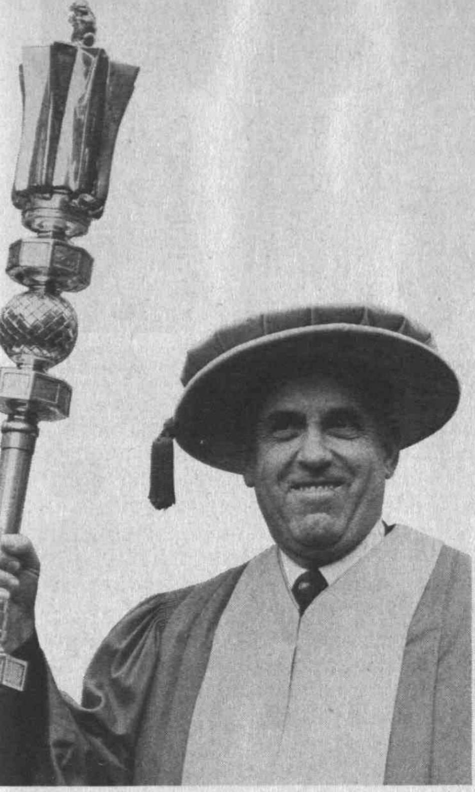
"Let it Be a World of Mutual Understanding"

At 10:30 a.m., Helmut Schmidt, former West German chancellor, begins his address. He speaks of leadership: "The western family of democratic nations does need leadership and—given the weight and magnitude of these nations—that leadership will not come from the relatively small European nations. It has to come from America. . . ."

And recession fraught with east-west tensions: "The present world is marked by a twofold crisis. Number one, nearly all countries are deeply affected by a major economic recession, the most serious one since the 1930s. And number two, many countries and many people feel threatened by a growing east-west tension and by growing strains in the effort to safeguard peace.

He talks of economic recovery: "Helping the Third World must not be a matter of arms, but a matter of help and of political flexibility . . . Economic recovery is of much

Denman K. McNear, '48, Alumni Association president, as chief marshal.



greater importance than producing ever more weapons. . . ."

And finally he lists five parts of a "grand strategy" for dealing with Moscow: political and diplomatic efforts for stability and peace; mutual, not unilateral, arms limitation; economic cooperation; military deterrents and defense; and competition with the Soviet Union in "economic, technological, and educational assistance to the developing countries." (*See page A6 for entire address.*)

As Mr. Schmidt speaks, a number of the graduates along with some faculty members on stage wear green arm bands over their robes to signify their support of the European disarmament movement (see page A11).

"Whole Human Beings First"

Kenneth E. Dumas, '83, senior class president, announces that the Class of 1983 has contributed $11,078.82 toward the establishment of the Jerome B. Wiesner Student Art Gallery in the Student Center as a way of expanding the visibility of student art on campus. The gallery will be in what is now the East Lounge off the Lobdell Dining Hall.

"As we turn our brass rats around and head into the real world, I hope we will have the courage to be more than 'just engineers.' I hope we will be whole human beings first, taking the risks and making the sacrifices that will bring us deeper joy and security than money alone ever could. . . ."

These young graduates hold enormous potential to do anything they choose; they've braved four years of the rigors of M.I.T. and, stronger for it, look forward now to a new challenge. "I look at those eyes and I know they're going to go out and win," says Howard Johnson, former chairman of the Corporation.

They have learned to work hard, to focus their intelligence, to stay on a path with purpose, to set priorities, to ask questions, to solve problems.

The future, in the form of "after M.I.T." is now, bringing both uncertainty and excitement. Paul Gray, in his charge to the graduates, asks a question about that future: "What are the most urgent problems on the human agenda? My list begins with the numbing terror of nuclear war and the overriding necessity to cultivate peace on this planet. It goes on to include the amelioration of hunger and poverty, the eradication of racism, and greater care for our fragile environment. Closer to home, one of our most pressing problems is the need to give attention to the processes of our own national government—processes which seem unable to cope with the crosscurrents, pressures, and conflicting demands of contemporary political life."

He suggests that "your lists will differ in content and order from mine. Those differences are of little consequence. What matters is that all of us recognize the urgency of these problems and accept the fact that we have an unavoidable responsibility to work toward their solution."

And he concludes: "As you leave this special place, I urge you to have confidence in your powers, and to have faith in yourselves." (*See page A10 for complete speech.*)

"As we turn our brass rats around and head into the real world . . . Perhaps we will take jobs which do not pay the most but allow us more freedom and creativity and bring us more satisfaction. Perhaps we will have ideas and risk starting our own businesses and creating quality rather than simply producing profit. Perhaps we will find we are not engineers and become chefs and ministers and musicians and writers. Perhaps we will find we really are engineers, but let's strive to be more than just engineers."—**Duncan Borland, '83** (For Mr. Borland's complete piece, see page A5)

The Next Step: Employment

Jobs loom ahead for the graduates who celebrated last spring. Or do they in this recession year?

Robert K. Weatherall, director of career planning and placement, told me his views on the mood of the marketplace:

"Do you think it's the worst ever?" I asked.

"I think it's the worst probably since the depression of the '30's. There have been other years when the economy has treated M.I.T. students harshly, but it's not been like this.

"Parents have called us to ask if the market is really as bad as their son or daughter has been telling them. 'Yes,' we say. Then they ask if their son or daughter has been using the placement office," explained Mr. Weatherall.

Students, he says, feel that if they haven't found a job they'd rather stay here and keep looking, or find odd jobs in Boston, rather than go home and be badgered every day by their parents. "We haven't had this situation at M.I.T., at least not in this way, since I've been in this office—since 1969," he adds.

The strongest demand has been for electrical engineers and computer scientists. The demand has come not only from electronics and computer firms, but from almost every segment of business—from the airframe industry to oil and chemicals, even banking. Meanwhile, the airplane builders have not been very eager for aeronautics engineers and the oil industry has been a disaster for chemical engineers. Weatherall notes that a number of major industries which have gone on growing for nearly a century and to which M.I.T. graduates have gone in large numbers appear now to have reached maturity, with little prospect of growth in the future. Students, like the country at large, see the future in information processing and communications. A third of the mechanical engineering graduates in 1982 went to work with electronics firms, he notes. "I think it's important for students to realize that the best jobs may not be in the industries to which their departments have sent most of their graduates in the past. For example, chemical engineers may find their best opportunity with firms which don't have oil or chemicals in their name.

"What would you consider the least marketable fields?" I asked.

"One group of students who are hard-pressed are the students in the humanities, and students who are getting Ph.D.'s in the academic fields," he explained. Yet at M.I.T. it's hard to say that any one department is purely academic. But its possible to be an academic physicist as opposed to one interested in industrial questions.

"The academic world is very tight," he said. Yet if a student is an engineering Ph.D., then there are teaching opportunities. A Sloan School Ph.D. will also find opportunities to teach in the business schools.

I asked if he thought that given the job market, there was less incentive to spend the money required for an M.I.T. education. His answer: "I think we make a mistake at M.I.T. when we justify the M.I.T. degree, and the outlay for it, in economic terms. We make a mistake because a student can get an engineering degree from state schools and go to work for many of the same companies. What is different about M.I.T. is the intellectual quality of the place—the mark it leaves on the mind of the graduate. An M.I.T. education is a mental treasure which a graduate appreciates for the rest of his or her life. The public recognizes this.

"I think M.I.T. has never been more exciting intellectually," added Mr. Weatherall. "That's the observation of someone who's been here a long time," he added. "I'm impressed at how the firms say that the graduates coming out of places in M.I.T.'s league have never been better—better trained, more creative, more ready to work. It's an interesting contrast with what people are saying about the high schools.

"The liberal arts colleges have helped to create the notion that it is bad form to worry about making one's living," he said. "Yet to make oneself able to earn one's living in a creative and effective way is I think one of the things one should learn. And M.I.T. students learn it."

"We try to tell them that if they look around and take notice of what the world is up to they probably can find ways in which they can do what they'd *like* to do intellectually, and still make a living out of it. They can be mathematicians and they can make it so they remain rather unemployable—or they can make it so they are eminently employable. I keep telling them, for example, that many of the most famous mathematicians were not simply mathematicians. They also took interest in applied problems. The word 'pure' before the word mathematics is not a sign of virtue. It's simply a name.

"M.I.T. students continue to be bold in their ambitions. For example, so many of them want to become entrepreneurs, which involves plenty of risk. Napoleon said, 'every corporal in the French army carried a field marshall's baton in his knapsack.' I think every second or third M.I.T. student carries a draft of a stock prospective in his briefcase," says Mr. Weatherall.—*M.L.*

John D. Corley, Jr., director of the Concert Band

Leaving the Tool Factory

The following is from a column in The Tech *by Duncan Borland, a member of the Class of '83 who received a bachelor of science in humanities and social science.*

Some would describe the Institute as a tool factory, not only training people to build machines, but also turning them into machines: unthinking, unfeeling creatures, little more than cogs in the great military-industrial complex. Harvard turns out thinkers and leaders while M.I.T. turns out calculators who follow orders.

That image bothers me, because I think there is more than a little truth to it. So many people do not like, much less love, what they are doing, but continue anyway, hoping a job with a good salary will bring peace and happiness further down the road. The thing that most saddens me about M.I.T. is people who say, "I hate this f—g place," but are later likely to fondly regard their time here as the best years of their lives.

Engineering should be one of the most creative and exhilarating professions in the world. Approached in the right way engineering can be an art form as engineers strive to create functional and beautiful things to fulfill important needs as simply and elegantly as possible. Too often we spend our time and energy on projects that either fill no real needs or are simply too large and complex to be beautiful. Anyone can make things more complex; it takes insight and talent to make them simpler.

No wonder so many engineers find their careers unfulfilling, or see them as mere stepping stones to management. Management is, at best, a necessary evil. We need managers, but too many create stifling bureaucracy, concerned more with money than with quality. Yet the managers make the high salaries and the important decisions while engineers live comfortable middle-class lives without thinking too hard. It might not be a great life, but it is just good enough and just secure enough that the engineer will not want to rock the boat and chance falling overboard.

Nor will most engineers take a chance on grabbing a more substantial amount of power and control. Life is easier when the big decisions are made by someone else and one can work within a limited framework without having to answer, or ask, questions about the direction of our society. It is much easier to say, "It's not my responsibility. Blame it on the guy upstairs," than to wrestle with questions of the value of what one does, both to oneself and to the world.

I dream of a day when people are less specialized, when each takes responsibility for the seeds he sows and the fruit they bear. I dream of a society in which values deeper than mere economics form the basis for decisions, where people place more emphasis on their development into whole persons than on their financial security.

Of course an individual cannot do everything, and financial security can be helpful for the exploration and satisfaction of our emotional, intellectual, and spirtual needs. But it is a grave mistake to hope to find peace and security through money alone. The poorest people are those with lots of money who spend their lives trying to acquire the additional amount which will bring them happiness; others, with little money, radiate peace and a deep joy inexplicable by any rational, materialistic system of accounting.

The joy comes from discovering who they are and what they truly love and having the faith to follow their hearts and do it. Strangely enough, when people let go of their worries about the future and pressures from the past and begin to live in the present, aware of who they are and what they are doing right now, things work out. Whatever people need falls miraculously into their laps at just the right moment if they are only aware enough to see, and trusting enough to take, what is given to them.

As we turn our brass rats around and head into the real world, I hope we will have the courage to be more than "just engineers." I hope we will be whole human beings first, taking the risks and making the sacrifices that will bring us deeper joy and security than money alone ever could. Perhaps we will take jobs which do not pay the most but allow us more freedom and creativity and bring us more satisfaction. Perhaps we will have ideas and risk starting our own businesses and creating quality rather than simply producing profit. Perhaps we will find we are not engineers and become chefs and ministers and musicians and writers. Perhaps we will find we really are engineers, but let's strive to be more than just engineers.

Toward a World of Peace and Understanding

Helmut Schmidt

Following in the text of the address given by Helmut Schmidt, immediate past chancellor of the Federal Republic of Germany, at the Commencement Exercises of the class of 1983 on Friday, May 27.

It was three centuries ago that some Germans from Krefeld, which is a town nearby the present German capital of Bonn, left their homes on the old continent to settle in your country. They looked for a new beginning, bringing scarcely more with them than their ability to work, their discipline, their skills, their religious beliefs, and last but not least, their deeply rooted will for freedom—their conviction that freedom meant freedom from hunger, freedom from war and freedom to live according to one's faith.

Since then, American and German history are deeply interwoven. America became the destination of many more German immigrants during the 19th century and especially during this century, when Hitler persecuted the Jews. The ideas of human rights and of a constitutional state which for the first time in history had been brought to reality in America became contagious in the Old World, and America welcomed those who were persecuted in Europe because of their unyielding will and wish for freedom. Certainly it was not the worst kind of people who found a new home on America's soil.

Then twice in this century America became involved in European wars which turned out to be world wars. The nations and countries involved in these wars have had to take different lessons from that period of our common history. We Germans had to learn that there is no way to change our geostrategic situation in the center of the rather small European continent. We, therefore, had to change our attitudes towards all our neighbors; and we Germans have more neighboring nations than any other country in the Americas or in Europe or in Africa or even in Asia—except Russia and China who also have many neighbors. And we Germans did learn our lesson—first, in Chancellor Adenauer's time and with the help of our western neighbors and some foresighted Americans like Harry Truman, John McCloy and others, vis-a-vis the west; and second, later in Chancellor Willy Brandt's time and my own, vis-a-vis the east. Our becoming a reliable and valuably contributing member of the Atlantic alliance and the European community and our treaties with our eastern neighbors for mutual renunciation of force were the main results of our learning our lesson from World War II. But others also have learned from history. This is certainly true for the reconciliation between France and Germany mostly due to men like John Monet, Robert Shuman, Charles deGaulle, and Giscard d'Estaing.

Certainly, also, your great nation has learned from the wars. You had to learn to live up to your enormous worldwide responsibility. We will never forget George Marshall, nor John F. Kennedy, nor will we forget that under Lyndon Johnson and Richard Nixon the roads were being paved for arms limitation between west and east. I would name at least the test ban, the non-proliferation treaty on nuclear arms, Salt I, the ABM Treaty, and later on the Salt II Treaty. Here we saw true American leadership at work, and we Germans liked it and we were willing to follow.

A Dangerously Wide Diversity

The western family of democratic nations does need leadership and—given the weight and magnitude of these nations—that leadership will not come from the relatively small European nations. It has to come from America—even if Americans don't like it from time to time and even if some Europeans don't like it, and even if they say so. It has to come from America—even if the Japanese don't like it too much without saying so.

The present world is marked by a twofold crisis. Number one, nearly all countries are deeply affected by a major economic recession, the most serious one since the 1930s. And number two, many countries and many people feel threatened by a growing east-west tension and by growing strains in the effort to safeguard peace. The political situation is characterized by a deterioration in west-east relations. Afghanistan comes to mind, and Poland, and other examples—for instance, the vast Soviet buildup of medium-range ballistic missiles, the arms race. Altogether we observe the deterioration of diplomacy into shouting matches or even economic warfare. The consequences are growing mutual suspicion and growing deficits in mutual calcula-

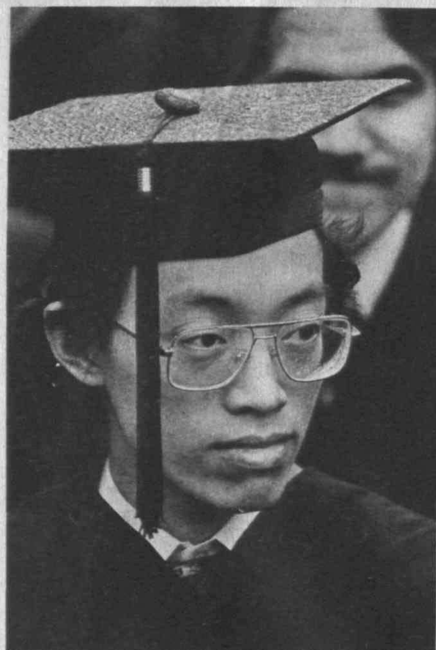
bility. To deal with the Communist east we clearly lack one commonly accepted—and I quote my British friend, Peter Currington—positive political strategy for dealing with the Soviet Union. I hope we can generally agree that we are searching for a restoration of a stable east-west equation. But as regards all important elements of that search for stability, the debate within the west is dangerously wide.

Since the Nixon/Ford/Kissinger era the superpowers have lost their mutual confidence in the calculability of behavior on the other side. The Helsinki Conference on Security and Cooperation in Europe—in which both super-powers participated in 1975—was by no means successful enough. Salt II as a treaty never came legally into force, and cooperation with the Soviet Union and detente have become dirty words for many. Some even have come to believe in economic sanctions and economic warfare.

The Soviet attitude is characterized first by a combination of an inferiority complex and a security complex vis-a-vis the west. Both together lead to an enormous overdoing of their military efforts. It is characterized second by inherited Russian expansionism; and third by caution, at least since Krushchev. My personal guess is that the international behavior of the Soviet Union under Andropov will altogether not differ much from the behavior under Breshnev. That means that there is an inherent threat, and there is also implied a calculable amount of rationality.

45 Minutes to Soviet Tanks

Let me insert here a word on the German perception of that situation. We Germans, as a divided country, have put all our eggs into the western basket. I cannot foresee any political development within this century which would make us change. We have understood that equilibrium between west and east cannot be maintained if the Federal Republic of Germany does not put its own full weight into the western basket. We, therefore, joined NATO—to which, in case of emergency, we will provide



Rain formed sparkles on graduation caps; hoods and umbrellas framed faces.

1,300,000 fully trained and fully equipped soldiers. This is what a country can do within seven days if it has not abandoned conscription.

On the other hand, we dislike loose talk about waging or winning wars, and we dislike loose talk about our living on a battlefield. Germany's territory is about the size of the state of Oregon. But in Oregon you have only 2.5 million people, while in Germany there are 66 million people. In Oregon, you have no nuclear weapons, while in Germany there are already more than 5,000. In Germany, there are not only German forces but also American, French, British, Dutch, Belgian, and Canadian forces. Think of your own people living in such an environment in such a densely populated area. From my home city of Hamburg it takes just 30 minutes by car to reach the Iron Curtain. If you are allowed to pass through, it takes you another 15 minutes until you meet the first Soviet soldiers and tanks. And, of course, it doesn't take them more time to get to my place, either.

These facts, I hope, will make you understand why we Germans will never be at the forefront of cold warriors. We certainly want to maintain the balance of military capabilities. We saw that balance endangered by the enormous buildup of Soviet SS20 missiles and I am one of those responsible for the double-track decision of NATO three-and-one-half years ago as far as German participation goes. I have not really changed my mind since then.

The Need to Curb the Arms Race

If the public in Italy, Belgium, Holland, and West Germany is convinced by the end of this year that America has undertaken every necessary and possible effort for a compromise solution at the Geneva negotiations and that it was the Russians who prevented a result, then I think you may expect those people to accept deployment of additional American strategic weapons on their soil in western Europe. But the Europeans will need to be convinced that the west really has undertaken a most sincere and serious effort for compromise and negotiations.

The European nations more and more feel that their lives are at stake if the arms race cannot be halted. They are more and more afraid of military strategies which employ first use and even early first use of nuclear weapons on our side in Europe—military strategies which thereby may imply destruction of what we seek to defend.

Many Americans—and many in this audience—are concerned with that as well. And they are right to be concerned. Furthermore, it is by no means necessary that we stick to such strategies. For all these reasons we will have to devise strategies which we are morally able to defend. We therefore have to reappraise our military strategy, and that will take time. We will need honest discussion, and that may take years.

Military strategy is just one of at least five components of a grand strategy vis-a-vis Moscow. The components are: first, our political and diplomatic behavior in order to achieve stability or peace; second, cooperation and mutual, not unilateral, arms limitation; and third, economic cooperation. Only in the fourth place comes the question of military strategy of deterrents and actual defense. The fifth—last but by no means least—is competition with the Soviet Union in economic, technological and educational assistance to the developing countries of the Third World.

In light of the presently increasing danger of political, economic, and military confrontation, it is necessary that we bring back to our own attention a few basic facts. One of these is that our Atlantic Alliance has been a successful alliance, has

preserved peace for all those who are members of that alliance, and has a prospect of being capable of doing that in the future.

It is a fact that Russia was and remains an expansionist power. But there is no Soviet overall military superiority. It is true that unilateral buildup of Euro-strategic SS20 missiles has created great problems and, therefore, has to be corrected. No Russian and no Communist is ten feet high.

Helping the Third World must not be a matter of arms, but a matter of help and of political flexibility. Right now almost all the countries of the world are being hit by economic recession and depression. Therefore, in many parts of the world not only economic but also political stabilities are endangered. Therefore, economic recovery is of much greater importance than producing ever more weapons.

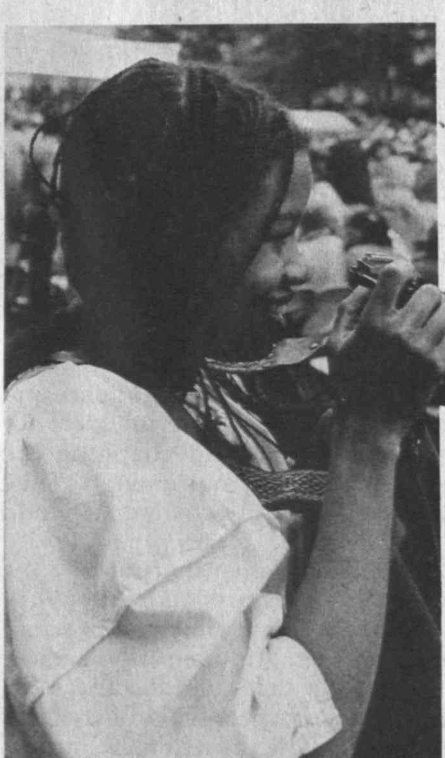
Leadership Needed

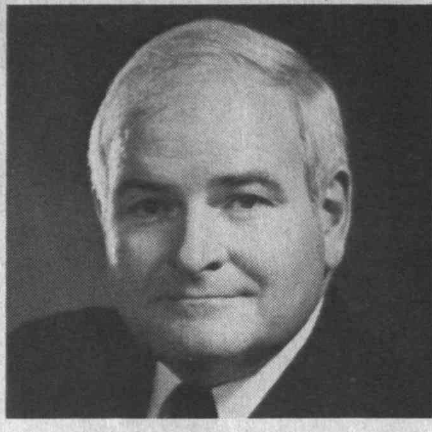
These basic facts roughly characterize the present situation of the world. This present world differs some from the time of Pierre Harmel's report to NATO in 1967 when he was Belgium Foreign Secretary or from that when Lester Pearson and other wise men articulated the basic philosophies of our alliance in 1956. The world has changed a bit. We need a new appraisal of our grand strategy. But the basic insights of men like Lester Pearson or Pierre Harmel remain true. We have to re-establish their three guidelines: one, partnership within the alliance by consultation before decision; two, jointly seeking capacity for deterring and if necessary defending ourselves against aggression; and three, the will to cooperate with the Soviet adversary not only economically but even more so in mutually limiting armaments.

All this takes leadership. Leadership among sovereign nations has nothing to do with command and control. It has to do with setting examples. It has to do with questions and answers and new questions and new answers. It has to do with discussion and with consensus by discussion. And this exactly is the point where your task comes into focus. In an open and democratic society no leader can make his decision alone. No leader is exempt from criticism. Nor is he exempt from advice. He needs to convince and to carry his own people. Our peoples are choosing and influencing their leaders. So you will be doing. Please see to it that you are well prepared to analyze and judge and then make your influence felt. A leading nation has to know and understand the world outside its own borders. Please make sure that you sincerely try to understand the world outside the American borders.

I have spoken today to posterity because all of you will have to work for a world to come—a world which is just now in the making, a world the shapes of which are just emerging from the upheaval of the present dangerous situation of our global society. Let it be a world of peace. Let it be a world of mutual understanding. Let it be a world of shared prosperity and a world of freedom and human rights.

In all dangers there is always a chance. There is a chance if we really and sincerely try to learn the lessons from history.





No Singular Truths

Following is the text of the charge to the graduates delivered by President Paul E. Gray, '54, to members of the Class of 1983 at Commencement Exercises on May 27, 1983

In a few minutes you will be walking across this platform and into a new life. The quality of that life will depend as much on you as on any forces of politics or nature which you may encounter along the way. Before you leave, I would like to say a few words about the nature of these encounters. How you deal with them—what talents, what assumptions you bring to bear—will in large measure determine the quality of life in our world.

Yes, you have experienced and acquired the powers of science and technology. You have tools and potential that few can claim. But I must tell you that while science and technology are powerful tools for understanding and changing the world, they are not enough. They are not enough to change the world for the better.

In the nineteenth century, the idea of progress—social progress—was inextricably tied to scientific progress. It was, really, an article of faith that scientific and technological progress would inevitably lead to a betterment of the human condition. Today, we say we know better. But do we? Do we still tend to misplace our faith?

My colleague, Leo Marx, Kenan Professor of American Cultural History here at M.I.T., put the dilemma particularly well in a recent address, when he said:

"To dismiss the possibility of a scientific or technological 'fix' is a commonplace . . . nowadays. . . . The fact is, however, that the dangerous idea of a technical fix is deeply embedded in what was, and probably still is, our culture's dominant conception of history . . . [But] our ability to understand and control the natural environment is only of marginal importance in the enhancement of our ability to understand and shape the social environment. That is why we have made so little progress in closing the famous gap between the 'two cultures.' The diffusion of scientific and technological knowledge, however complete, cannot be the decisive factor in solving the most urgent problems on the human agenda. They inhere in the man-made, not the natural, environment, which is to say that they are political, not scientific, and scientific progress cannot be the basis for this resolution."

What does this mean for us who are here and you who are leaving? It means that we must continue to cultivate an academic program here at the Institute which embraces the variety of ways of seeing and knowing, of thinking about and grappling with the important questions of our time. It's true that scientific education and progress demand specialization, but we must guard against the companion pressures toward isolation. We have a responsibility to elucidate not only the powers but the limitations inherent in different disciplines, and to explore ways in which they inform each other.

And you who leave here today have a responsibility to recognize the limitations as well as the power of science and technology in your own lives, and to place confidence in other human dimensions as well.

You must. We must. If we are to successfully come to grips with the most urgent problems on the human agenda. If we are to have a future worth having.

Accepting our Responsibilities

What are the most urgent problems on the human agenda? My list begins with the numbing terror of nuclear war and the overriding necessity to cultivate peace on this planet. It goes on to include the amelioration of hunger and poverty, the eradication of racism, and greater care for our fragile environment. Closer to home, one of our most pressing problems is the need to give attention to the processes of our own national government—processes which seem unable to cope with the crosscurrents, pressures, and conflicting demands of contemporary political life.

Your lists will differ in content and order from mine. Those differences are of little consequence. What matters is that all of us recognize the urgency of these problems and accept the fact that we have an unavoidable responsibility to work toward their solution. It is not enough to rely on the President, the Joint Chiefs, and the Congress to find the proper balance between the real needs of national security, the development and deployment of nuclear weapons, and the need for progressive, certain, and balanced

disarmament. Nor is it wise to consider such issues to be primarily the province of the scientific community. We each have a responsibility to inform ourselves about the realities of these complex matters and to make our voices heard. And it is not enough for us who are citizens of the United States to deplore a federal budget which seems at once uncontrollable, unbalanced, and unfortunate in its priorities. We each have a responsibility to urge those who act upon our political will to seek a better balance between competing needs and to avoid the seductiveness of narrow and special interests.

These issues, indeed *all* the most urgent problems on the human agenda, will soon be in the hands of your generation, in *your* hands. The leadership you provide, the priorities and objectives you espouse will, in large measure, determine what the future will hold for your generation and for the generations that follow. Of course, conflicts of national interest will arise and individuals will have different views regarding the use of scarce resources and the requirements for national survival. But I earnestly suggest to you that each of us must strive to build nations and a world in which resources and energy and creativity are bent toward peaceful and humane uses: to the nuturing of children, to the health, well-being, and fulfilling of all of its citizens.

And that is the challenge I set before you today. As you leave this special place, I urge you to have confidence in your powers, and to have faith in yourselves.

Good luck and Godspeed.

Dis-Armbands: Quiet Demonstration Stimulates Debate

The dis-armband demonstration generated controversy as exemplified in a debate in the pages of *The Tech*. Wrote V. Michael Bove, '83: "I am a graduating senior, I support disarmament negotiations, and I am not wearing a green armband during today's commencement exercises . . ."

"The green armbands will be interpreted by national and international news media and particularly by former Chancellor Helmut Schmidt as approval and support of West Germany's Green Party," he continued.

"Had there been more discussion of what they stand for besides disarmament, I suspect far fewer people would be wearing the armbands today. . . ."

"If you got one of those funny green things on your arm and you don't know anything about the Greens, I hope you're feeling sort of silly. . . ."

Countered Jim Vlcek, also in *The Tech*: "Today I will receive my bachelor's degree in electrical engineering . . . I will wear a green armband to demonstrate support for efforts to bring about nuclear disarmament . . . I do not wholly agree with the viewpoints of the people sponsoring the dis-armbands.' I share the feeling with them, however, that there is little sincerity in the efforts of all parties to halt the current nuclear arms race. In this context, I feel that I not only should, but indeed *must*, display my feelings in whatever manner is available to me. . . .

" 'With enough shovels' we might all survive a nuclear attack, said an administration official in a fit of macabre pique. Perhaps with enough armbands, we might prevent that same attack."

President Gray foresees "sweeping changes" in the teaching of everything from history and literature to engineering and architecture, from foreign languages, political science, and economics to physics, chemistry, and mathematics.

Project Athena: A Revolution in Education By Computerizing M.I.T.

A $70 million project to bring a wide range of computers and computing technologies into the mainstream of an M.I.T. education—a revolution in education, say its advocates—was launched at the Institute late last spring.

Two principal objectives, say two of the founders of Project Athena (named after the Greek goddess of wisdom), Professor Michael L. Dertouzos, Ph.D.'64, and Joel Moses, Ph.D.'67, of the Department of Electrical Engineering and Computer Science:

□ To prepare M.I.T. students to make effective use of computers in their future work.

□ To provide all M.I.T,. students with the "deeper educational process" that computers can assure.

President Paul E. Gray, '54, thinks Athena "may be the largest step forward in M.I.T.'s long history of contributions to education." He believes it will "encourage new conceptual and intuitive understanding in our students."

The two principal sponsors of Project Athena—Digital Equipment Corp. and International Business Machines Corp., the world's two largest computer manufacturers—will independently provide a total of nearly $50 million in equipment, software, service, maintenance, support, research grants, and on-campus personnel to develop the project over the next five years. In addition, M.I.T. will raise some $20 million to support the project.

The effectiveness of these many different elements for users from many different departments throughout M.I.T. will depend on coherence and compatibility, the major problems facing Athena's advocates. The computers and computer systems must work together so that the network created by Athena enables "individuals throughout M.I.T. to share each other's information and programs and work together on problems and ideas in creative new ways," President Gray says. This effort is crucial, he believes. With coherence assured, President Gray foresees "sweeping changes" in the teaching of everything from history and literature to engineering and architecture, from foreign languages, political science, and economics to physics, chemistry, and mathematics.

Project Athena does not propose "to stress computation in place of contemplation," President Gray emphasized in his address to the alumni at Technology Day. Rather, he is convinced that it will "add a new dimension to the ways of seeing and learning that are traditional at M.I.T."

Professors Dertouzos and Moses envision computer terminals organized in regional networks throughout the campus—including interactive graphics terminals, personal computer stations, and word processors. There will be "scores" of mainframe computers, storage devices, and printers, they say—all organized to serve the classroom and homework needs of students throughout the campus.

But all that equipment is not really the issue, says Gerald L. Wilson, dean of the School of Engineering who has been a principal advocate of Athena. The point, he says, is for students "to interact directly with the graphics, to change a component to see what happens, to ask 'what if, and explore answers in an interactive way." It's that direct and personal interaction in which all students and faculty will share that "makes this project so exciting. Alumni may share in it, too, continuing to subscribe to the software support systems that will have been so useful to them as students," says Steven Lerman, associate professor and division head in civil engineering.

In the first two years, there will be 63 minicomputers and over 300 display terminals, personal computers, and advanced graphic work stations from DEC and 500 personal computers from IBM. In the last three years, Digital will add 1,600 personal computers and IBM 500. After five years, when Athena's first-generation hardware will be obsolete, M.I.T. may turn to the strategy adopted by other schools, asking each student to purchase a then-current personal computer—perhaps as a tuition add-on. But in its first years Athena will be more structured, say Professors Dertouzos and Moses, so that the contributions to education can be more carefully planned and studied.

Classes

08

Mrs. Osborne and I plan to drive down on June 10 from our home in New Hampshire to attend the Technology Day activities. We plan to call on Mrs. George W. Smith, whom I have known since 1899.

The list of surviving members of the Class of 1908, which was sent to me in February 1983, now has only two members listed besides myself. I personally know both, and hope that **Franklin Towle** will join us at the luncheon on June 10.

Leo Loeb is in a nursing home and won't be able to come.—**Harold S. Osborne**, Secretary, 375 Highland Ave., Upper Montclair, NJ 070043

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Hamilton Merrill died at his home in Orleans, Mass., on November 6, 1982. He was 91 years old. Before retiring in 1956, Mr. Merrill was president of Manning, Maxwell, and Moore Inc., a valve and gauge manufacturer that is now part of Dresser Industries Inc., Dallas. He was a former resident of Bridgeport, Conn., and was a life trustee of the University of Bridgeport. He is survived by his wife, the former Phyllis Gordon, two daughters, nine grandchildren, and ten great-grandchildren.

James A. Cook, 92, retired president and general manager of the former Lynn Gas and Electric Co., died in September 1982 after a lengthy illness. He served as a corporal in the Army Corps of Engineers in Mexico during the 1916 uprising. Mr. Cook was a past president of the New England Gas Association. He leaves a son, a daughter, six grandchildren, and two great-grandchildren.

Harold Mitchell's daughter writes to say that her father died December 21, 1982, after a long bout with a stroke. She says, "He was one of the leading ornithologists in New York state and had been active in many conservation activities in his retirement. He had been president of the Buffalo Museum of Science Board of Managers, the Buffalo Audubon Society, and founder and first president of the Buffalo Ornithological Society. He had been looking forward to his 70th Reunion at M.I.T. but just wasn't able to make it. His wife survives him and is now living with me. They had a 63rd anniversary last May."

Two other deaths of 1912 members were reported without further details: **Ora M. Merry** of Minneapolis, Minn., on November 14, 1982, and **Ned Osthaus** of Scranton, Pa., in August 1981. We extend our condolence to the families of these classmates.—*Ed.*

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Allen Brewer sends a "contribution to the 1913 class history"—his poem, "Seventy Years In Retrospect":

Good Tech folks, I hope you'll permit this review
Of a class with a history which may interest you.
On this 70th Reunion of the Class of Thirteen,
Then, they faced a stern world with visions supreme.
They offered their talents gained from the Tech mill,
To build "better mousetraps," their ideals to fulfill.
As "frosh" they'd worn uniforms, strictly enforced,
Because drill at the armory was part of the course.
Then, with the chips down and a war job to fill,
They put in full time with a smile and a will.
They'd gathered on Rogers steps, always with pride,
They'd climbed Walkers stairs without missing a stride.
Engineering A taught them the devious facts
Which shaped the design of their later-day acts.
They sang the Stein Song at the Pops, unconfined,
Life at Tech was severe, tho never a grind.
They won both their field days, worked with the Tech Show;
They lived their lives fully, their pep overflowed.
Some sought out the Boylston Street "chapel" at times,
To study (?) agriculture via corn, hops, and rye.
We hope thirteen's been a class to be proud,
All credit to Tech, those who've stood out in the crowd.
Technology gave us that inborn instinct,
How to plan, how to judge, how to love, how to think.

—**Rosalind R. Capen**, Assistant Secretary and Treasurer, 7 Brackett Point Rd., Biddeford, ME 04005

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From **C. Loring Hall**, a brilliant idea. He writes that his old diaries turned up when he moved—covering 1907 to 1919, including all four years at M.I.T. He notes that "Tech has such a reputation for being tough to get through that it is a revelation to read how much time and energy we had for extra-curricular activities, such as football, track, concerts, drama (The Tech Show was famous then) and just plain socializing. Also, Military Service was a required course then and took up an hour nearly every day. Nobody liked it much, but we had no choice. The only reference to hard work is in regard to long hours of study at home. I was a commuter, living five miles south of Boston. Sometimes walked or rode a bicycle, but most of the time took the street-car (five cents each way)." Here are the first entries about M.I.T.:

"*June 21, 1911*—Went to M.I.T. this morning and paid five dollars for my examination fee. Studied history in the library until 11 o'clock, then about 15 of us went over to Engineering Building A and took the U.S. History exam. Freeman, Hyneman and I had lunch at Hood's Creamery, then went back and took the physics exam.

"*June 22, 1911*—Took the English and Plane Geometry exams.

"*June 23, 1911*—Took three more exams today. Algebra A and B and German. They were all 'pipes' as the fellows say; the Algebra A, for instance, was supposed to take 1¾ hours, but Eddy and I and some other M.A.H.S. (Mechanical Arts High School, a Boston public school that taught trades and was as near a prep school for M.I.T. as there was—at least a dozen of us from M.A.H.S. '11 went on to M.I.T. together) went to eat at a restaurant at the corner of Berkeley and Boylston Streets, and it was awful, especially the service."

Two notes from Fred Vogel—a pleasure indeed. First, he wrote that it hurt him to put his wife, Mary, in a nursing home but that she required more care than he was able to do; they had hoped to attend the M.I.T. Reunion and visit New England together, and he plans on doing this trip with a grandson. In his second note he advises that he is over 90, legs not as good as they used to be, but otherwise cannot complain. He is able to visit Mary at the nursing home nearly every day and sometimes has dinner with her. His plans were still in the making to join Max Seltzer and the Class of 1918 in going to M.I.T. on June 9 to 12, and perhaps seeing the places of his youth for the first time in 55 or 60 years.

A note comes from M. Janet Gray, who is **Sol Schneider**'s daughter. She says that over the years she and her dad had become "winter snowbirds," escaping to Florida or Arizona, but that this winter they remained at home. Several months ago Sol had surgery, with and excellent recovery. However, he had a stroke which affected only his walking. He claims he never learned to dance while a student at Tech, as he was too busy studying. Now when he gets his feet untangled he will expand on his physical therapy treatments. Presently he is at Resthaven Center, Room 319, N. Malin Road, Broomall, PA 19008.

Evers Burtner writes, "Although held up last January in Florida and knocked out with three broken or cracked ribs and a six-day hospital stay, am okay now. Went out with **John Homan**, who was planning his annual trip to southern England in June.

"Daughter-in-law Virginia Burtner developed a surprise 90th birthday party, and despite the rain nearly 90 were present, several from nearly 100 miles away, steam launch friends. Five days later gave a 50-minute talk to the Essex Historical Society on recollections of Essex camp life 1908 and the Gloucester-Halifax 1922 Fisherman's Schooner Race. The newspapers gave me the rawest report in all my 50 years of yacht measuring. Dana Story, '41, helped organize the event, which even included a birthday." Congratulations, Evers!

A note from **C. Ellis Ellicott, Jr.**, reports that his family had a reunion on his 91st birthday, and plan another in August on Deer Island, Maine, where his daughter has a summer place. He was lucky last summer: planned a fishing trip to Northern Ontario, but a few days before leaving he developed a blood clot in the leg—a real emergency—and fortunately quick hospitalization saved him from an amputation. Ellis has been "re-allowed" to drive a car after six months, and states "It's a big help!" Ellis attended his 70th anniversary at Johns Hopkins in April—the small class in 1913 totalled 42 graduating, and now only four are left. His only brother, Valcoulon, '16, died suddenly February 10. He

went on from M.I.T. to Hopkins with degrees in Medicine and Public Health.

Francis Hann sent me a cute note stating, "So, Joyce, you kicked yourself in the face, so to speak," referring to my broken hip—and sent me his best wishes for a complete recovery, which stage I have now reached! Thanks to each of you for your fine notes and interest. May the letters keep coming—we need them for the next issue.—**Joyce E. Brado**, Class Agent, 491 Davison Rd., Apt. 9, Lockport, NY 14094

16

Extraordinary—this note from **George Crowell**: "I am feeling OK and still active in the business." . . . Other responses to our luncheon meeting notice included this one from **John Fairfield**: Too far, too old, too inert, too lazy, too poor." . . . From **Allen Pettee**: "Sounds good but I have to eschew all such invitations." . . . From **Shatswell Ober**: "I will not be able to come, sorry but it is true. More power to all and 'keep breathing.' . . . From **Fred Kenney**: "Sorry that I will be unable to attend. My regards to all who may be there." . . . From **Walter Wolfe**: "I would very much like to attend, but due to the distance it is impossible for me to be there. I send greetings to all my fellow graduates." . . . From **Dina Coleman**: "Unfortunately I will not be able to be there. I have just finished a week's stay in the hospital with pneumonia, and they say that it will take a month to six weeks to recover. Give my best to the boys and girls." . . . From **Charles Crosier**: "Sorry, I am physically unable to participate in this event. Best wishes."

From **Joel Connolly**: "Sorry that I cannot attend this year." . . . From **Mickey Schur**: "I'm sorry that I can't join you. I'll be in England in June. Better luck next year." . . . From **George Ousler**: "Sorry—will not be able to attend." . . . From **Viola Hobbs**: "So sorry but my husband, James B. Hobbs, is ill and not able to attend." . . . From **"Mac" McCarthy**: "Regret that I will not be able to attend. Please extend my kind regards and best wishes to all classmates and wives who are there." . . . From **Will Wylde**: "Again, I have to say that I will not be able to attend. We do go up to western Massachusetts for a visit each summer (from our home in Bradenton, Fla.), but it is to attend the Wylde family annual reunion. That always occurs in late August, so we only go up for the month of August." . . . Also had a change of location from **Ralph Mills**, he is now in Summerland Key in Florida.

Talked with Anne (Mrs. **Izzy**) **Richmond**, who indicated that she and Izzy couldn't attend because she would be enjoying her 50th Reunion at Wellesley on the day of our luncheon. Izzy and Anne enjoyed a vacation in Spain last winter. At a recent banquet of ROTCH Scholars, Izzy was honored as the oldest living member of the group. He spoke briefly at the banquet and received a standing ovation. . . . Also spoke with **Doug Robertson**, and he was scheduled for dental surgery so he couldn't attend. . . . Grace and **Dan Comiskey** are both well but sent along their regrets for not being able to attend. . . . **Barney Gordon** had previous plans to be in Washington on our date for the luncheon. He's feeling fine. . . . Frances and **Henry Shepard** are well but were uncertain about attending. Frances and **Paul Duff** are both fine and indicated that they (along with son, Dr. John Duff, and wife, Esty) would attend. Sibyl (Mrs. **Ralph**) **Fletcher** also planned to attend. However, since so many of our "regulars" had conflicts which precluded attendance, we postponed our 67th Reunion luncheon. . . . We heard that Millie and **Charlie Reed**, (along with their and our good friend, Lansing Warren) were going to be at the 1918 reunion, but had to change their plans.

We regret to report this note from Diana Lucas: "My Dad, **Eugene Lucas**, died on April 26, 1983. . . . He was so fond of his 1916 classmates, although he did not participate in all of the merry reunions! I've found several snapshots of him with his friends in their marvelous red jackets." . . . Keep eating, drinking, walking, breathing, everything in moderation, and yes, of course, keep writing.—**Bob O'Brien**, Acting Secretary, H.E. Fletcher Co., Groton Rd., West Chelmsford, MA 01863

17

Members of our class were delighted to learn last April that on Commencement Day this year our classmate **Penn Brooks** would be honored by having his name given to the new residence conference center at M.I.T.'s Endicott House in Dedham. The dedication took place on May 27 as scheduled and included an adjacent garden named in honor of Penn's late wife, Carol Wright Brooks.—**Walter J. Beadle**, Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348

18

In less than two weeks (at this writing) we will be celebrating our 65th Reunion at M.I.T. together with graduates from earlier classes. I expect to report in the next issue of the *Review* an historic event.

In April **Charlie Tavener** was presented with the Exchange Club's seventh annual Book of Golden Deeds Award at the Boca Raton's chamber of commerce breakfast. For the past three years he has volunteered his time as acting executive director of the Boca Raton Downtown Redevelopment Agency. Prior to moving to Florida in 1970 he had been owner of Kay and McDonald Inc., manufacturers of heating equipment, West Orange, N.J. for 30 years. Charlie has had many interests, particularly in Regional Planning, in the various communities in which he has lived, including chairmanship of the East-West Freeway Engineering Committee in West Orange. We expect to see Charlie with his Rhoda at our 65th waiting for the next challenge.

From California comes a recent article in *Pacific Oil World* about faithful **John Abrams**. "First Geothermal Steam Well in Imperial Valley" gives an account of this pioneer project now 24 years old. John, now 89 and retired after receiving his masters in chemical engineering from M.I.T. went on to a career in oil and natural resources development. He designed, built, and operated a natural gas plant in Signal Hill. The article notes that he is a grandson of James Henry Abrams, a Pennsylvania oil pioneer who was the first to cargo oil by steamboat from Oil City to Pittsburgh.

G. A. Sackett

After reporting the passing of **George Sackett** in the July issue, I now have additional information on his career. After leaving the Institute in 1948, he joined the Goodyear Tire and Rubber Co., testing fabric for balloons to be used in France for aerial observations. Ten years later Goodyear sent him to Sumatra to be chemical director of their Chemical Rubber Plantation. In 1955 he moved to Connecticut where he became director of retread development for the Armstrong Rubber Co., and in 1970 he retired. He and his wife Marie traveled extensively in Asia and Europe. He was a member of many technical organizations, including the Crude Rubber Committee of the American Chemical Society and the Rubber Manufacturers Association Technical Advisory Committee. He authored many technical papers in his field. George will be remembered long and warmly by those whose lives he touched by his unfailing good sense, loyalty, and human interest and affection.

We have no details but record the deaths of **Jim Todd** in Nashville, Tenn. on March 24, 1983; **Oscar Andersen**, Santa Monica, Calif., on January 13, 1982; **Edgar Goldstine**, San Francisco, Calif., on January 5, 1983; **Charles Simpson**, Tampa, Fla. in 1978, and **Robert Gidley**, Dallas, Tex., on January 7, 1982.—**Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

19 65th Reunion

It is indeed gratifying to note that, as of the end of May, we have 46 replies to our attendance poll for our 65th Reunion in June 1984. Of these, 21 have plans to attend, some more tentative than others, with one more as a "possible." They are: **Aubrey P. Ames** and wife, **Pierre Blouke** (possible), **Benjamin H. Bristol**, **Oscar A. de Lima** and wife, **Charles W. Drew**, **Edmund J. Flynn** and wife, **Louis J. Grayson** and wife, **W.O. Langille** and wife, **George Michelson**, **Russell S. Palmer**, **John L. Riegel**, **John W. Rogers** and guest, **Timothy E. Shea**, **Morton A. Smith** and guest, **Leon I. Snow**, **James G. Strobridge** and wife, **William H. Vogt, Jr.** and guest, **Donald D. Way** and wife, **Francis A. Weiskittel**, and **Lester Wolfe**.

Your committee now has the needed information on attendance to go ahead with the details of organizing and preparing for the reunion. Replies to our poll contain items of interest which will be sorted out for future class notes.

We regret to report the death this April in Beverly, Mass. of **Leighton Smith**. Professor Smith earned his bachelor's, master's, and Ph.D. degrees at M.I.T. He served as an engineer in the Enlisted Reserve Corps during World War I. He was an assistant professor in chemistry at M.I.T. before joining Lever Brothers, where he was assistant director of research and development. He then joined the faculty of Tufts as a full professor until he retired in 1961. He was a member of the American Academy of Arts and Sciences and other chemical societies. He leaves a wife of 40 years and many nieces and nephews. Another credit to our class.

It is with equal regret that we report the death of **Henry R. Whiton**, who resided in Richmond, Va., on August 14, 1982. At M.I.T. he was a Course VI student. Unfortunately, we have no further information on his career but would welcome word from any reader who might help us in some future report.—**W.O. Langille**, Secretary, Box 144, Gladstone, NJ 07934

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A cheery note from **George Des Marais** reports that after a long stay in the hospital for Lois they flew to Ohio to stay with their daughter for several months. While there, George had a hip joint replaced, which must have been successful as George is now looking forward to regular meetings with his M.I.T. associates. We greatly admire your dauntless spirit, George. "Greetings to you steadfast members of the Class of 1920, Harold, Perk, and Al," writes George.

Harold Bower of 8400 Vamo Rd., Apt. 811, Sarasota, Fla., died last September 14. Before his retirement he was a chemical engineer with E.B. Badger and Sons. His wife, Dorothy, writes that he thoroughly enjoyed retirement in Florida, playing golf, fishing, and generally enjoying life. That is good to hear. Being alphabetically close to Harold in Course XV, option 3, I used to see a lot of him. He was unvaryingly good-natured and friendly. We shall miss him. He leaves his wife and two daughters.

Al Wason died April 17 after a long illness. Al had a distinguished military career serving in the

U.S. Army in World War I, then rejoining the army as a major stationed at Salina, Kans. in World War II. He was promoted to lieutenant colonel and transferred to the adjutant general's office in Washington. Al spent most of his business career with Westinghouse Electric Co. specializing in air cooling and conditioning. He authored the industrial process air conditioning section of McGraw-Hill's plant engineering handbook. He leaves his wife, Ella, two sons, and three granddaughters. I am indebted to Al's twin, **Elbridge Wason**, for supplying this information.

Robert N. Scott Baker of 305 Hamilton Rd., Wynnewood, Pa. died in May. No further information.—**Harold Bugbee**, 21 Everell Rd., Winchester, MA 01890

21

It's a cold wet day in late May as these notes are being written. Technology Day is only two weeks off. Your secretary is attending Betty's 60th Reunion at Simmons next week, but not planning to stay over in Boston for another week to attend Technology Day. I have heard that several classmates are planning to attend, however, and I'll report on that in the next issue.

A note from **Don Morse** tells of the recent death of **Chesterton (Chick) Knight**'s wife, Marion. The Knights had spent two months in Florida and had recently returned to their home in Bridgewater, Mass. Both Marion and Chick served on our 60th Reunion Committee, and we shall miss Marion at our 65th. Our deep sympathy to Chick.

News is scarce this month, so two Alumni Fund envelopes were particularly welcome. **Harold Cake** writes from King City, Ore., "No special activities—I just enjoy the sun (and rain) of Palm Springs in the winter and the lush green of Oregon the rest of the year, plus the many trips in and around the Northwest in our Cortez motor home." . . . **Roy Campbell** writes, "I would be glad to see anyone from Harvard or M.I.T. anytime, but summer preferred. Do drop in—I'd be especially happy to see any graduate of the School of Public Health. My mailing address is Star Route 2, Bath, ME 04530. I'm in a small village called Robinhood in the town of Georgetown, nine miles from Bath. I went to the Harvard-M.I.T. School of Public Health, got my certificate in 1921, and received a master of public health degree from Harvard in 1927." . . . Helga and **Jim Parsons** send a change of address from Naples, Fla., to 5225 W. Wendover, High Point, NC 27260. Jim, do you still have your summer place in New York state? Write me!

Assistant Secretary **Josh Crosby** writes, "We certainly missed you and Betty in Florida this winter. Hope things are going nicely with you. . . . **Herb Kaufmann** gets around on crutches now, and I'm sorry to report his wife Millie had a hospital stay, so we haven't seen as much of them as usual. We do have dinner or lunch with them once in while, though. . . . Marion and **Phil Payson** drove up from Fort Myers for the annual M.I.T. Club picnic, and I had a nice visit with them. . . . I haven't heard from **Helier Rodriguez** for some time and plan to call him before Claudia and I leave for our summer in Maine late in June."

Two death notices came from the Alumni Association this month: **Harry Cole** of Houston, Tex., on January 30, 1981, and **Herman B. Thompson** of Omaha, Neb., on October 19, 1982. The only information I have on these classmates comes from alumni registers. Harry was chief structural engineer of Lockwood and Andrews in 1955 and Herman was an engineer and contractor (in 1948) and district manager of Massman Construction Co. (in the 1950s).—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

22

After commenting on the **Marjorie Pierce** House in the May/June *Review*, I found that the **H. W. McCurdy** Lounge (in the crew house) was named in honor of our distinguished classmate who has done so much for rowing at M.I.T. Recently I had the privilege of reading Mac's biography, *Don't Leave Any Holidays*. The accomplishments of Puget Sound Bridge and Dredging Co. when Mac was president and general manager (1931-1959) were monumental. During that time the firm completed approximately $1 billion worth of ship and general construction work, including 100 steel ships, the repair and/or conversion of approximately 2,000 vessels, the construction of the Alaskan sector of the Distant Early Warning (DEW) Radar Line, all the naval air bases in Alaska, the army Port of Embarkation at Prince Rupert, B.C., as well as bridges, dams, highways, and tunnels throughout the Pacific Rim. In 1969 Mac received the achievement award for Construction Man of the Year by the Construction and Community Development Department of the Seattle Chamber of Commerce. Considering the sheer physical volume of important work done, particularly during the war years, we recognize Mac as having been one of our country's greatest business leaders.

An interesting note comes from **Ed Merrill** who is now comfortably settled in Tulsa, Okla. at 1722 S. Carson Ave., Apt. 1501. His grandson, Fred Merrill, Jr., M. Arch. '83, Married Wendy Krum, M. Arch. '81. They both work for competing Boston architect/planners which Ed says should keep their personal partnership interesting. . . . A letter from **R. A. (Stoney) Stone** tells of a move to 2759 Gulf Dr., Bay 126, Clearwater, Fla., and invites classmates to look him up. Travel experience over the years finds his order of preference to be: boat, train, bus, and last, plane. Stoney some years ago was president of the Tampa M.I.T. Club. Last May your secretary visited the Seabrook, (N.H.) Nuclear Power Plant, along with about 75 others for a walking trip through the works. Who should be one of the 75, but our old friend **C. Randolph (Randy) Myer** from Wilton, N.H. Randy is as spry as ever and sends his regards to all old friends.

A letter from Carol Spalding Nagel **"Dyno" Spalding**'s daughter and wife of William S., '53, tells us that her mother (who attended so many of our five-year reunions with Dyno) died last year. . . . **Morris Gens** of Brookline, Mass., who was one of our Boston standbys and a regular attendant at Alumni Days and our five-years reunions, died April 29, 1983. He leaves a son and three grandchildren. . . . **Jack Hennessy**'s wife, Octavia, more familiarly known to her friends as "Teddy," died May 9, 1983. She is survived by her husband Jack, a daughter, a son, and five grandchildren. . . . **George F. Hamer, Jr.**, of Newcastle, N.H. died on February 19, 1983. Before retirement, he was the head of the physics department at Mercersburg Academy in Pennsvlvania.

George P. Anderson, who was retired in Hendersonville, N.C., died on February 1, 1983. . . . **Harold R. Blomquist** of Centerville, Mass., died on March 9, 1983. He had been an electrical engineer with the New England Electric System for more than 35 years, retiring in 1965. He helped design and engineer the Yankee nuclear power plant in Rowe, Mass. An army veteran of World War I, he is survived by his daughter and four grandsons. . . . **Walter R. Moore, Jr.** died February 18, 1983 in Middle Grove, N.Y. and is survived by a son. He entered M.I.T. as a sophomore, after a year at the University of Michigan. . . . We learned from his daughter, Mrs. Barbara Cargill, that **Charles Herbert Taylor** died April 7, 1983. We regret the loss of these classmates.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

23

Bartlett Cooke has been presented with the Llewelyn W. Pitts award, the highest honor of the Texas Society of Architects, for "outstanding contributions to the profession of architecture." . . . **Howard Lockhart** writes that he has been retired since 1966 as a public utility executive, and finds time to work on charitable drives.

Martin H. Burckes died on April 10. He graduated in civil engineering with our class and took his S.M. degree in 1929. After leaving the Institute he served as R.O.T.C. instructor at Ohio State University and squadding officer in the statistical section of the national matches at Camp Perry, Ohio. During World War II his field artillery battalion went into position on the east coast of Oahu, Hawaii, supporting the Hawaiian Infantry Regiment. He became adjutant-general of the 88th Infantry Division, which formed the spearhead of the Italian Campaign. Later he served in Korea. He retired from the army in 1952. He was a 53-year member of the Theosophical Society in America and served for 20 years as superintendent of maintenance at the Krontona Institute in Ojai, Calif. He was a charter member of the Ojai Retired Business and Professional Men's Club.

Dorothy Cobb has reported the death of her father, **Howard Cobb**, on September 26, 1981. Howard attended the University of Colorado for two years, then transferred to the Institute and graduated with our class in electrical engineering. His professional career was spent with Fansteel Products Corp., Boonton Research Corp., and finally with Faircraft Radio Corp. as chief draftsman and chemist, all in Boonton, N.J. He was a member of Boulder Lodge No. 45 A.F. & A.M., a fellow of Radio Club of America, and a member and past president of American Electroplating Society, Newark. He was a member of the School Board and the Juvenile Conference Committee of Boonton. He travelled widely and had many hobbies—mineral and rock collecting, home shop projects, United States western history, genealogy, and photography.

John Cook died on March 12. John attended the Georgia School of Technology, then transferred to the Institute and graduated with our class in mechanical engineering. We have no information about his subsequent career. . . . **Harvey King** writes, "My wife for more than 61 years, Margaret E. King, died in our local (Fort Walton Beach, Fla.) hospital Saturday morning. We were married in 1921, so she came to Boston with me for my graduate work in architecture."

Edward McSweeney died on April 16. He graduated with our class in Business and Engineering Administration. He served in the Navy during World War I and after graduation entered newspaper work in Boston, then worked for Conde Nast Publications and Butterick Publications. In 1933 he founded Edward McSweeney Associations, management and marketing consultants. He served as director for numerous corporations. He was a member of the American Legion Publications Commission, American Management Association, National Committee Against Mental Illness, National Heart Committee, and Printing Industries of America, a member and director of the National Society for the Prevention of Blindness, chairman of the Printing Management Education Trust and of the Westchester Charter Revision Committee, and trustee associate and chairman of the Board of Trustees of Bard College. He was author of *Organization for More Efficient Management* and numerous articles on management and marketing. He received the Bard College Medal, Elmer Voight Award, Friedman Medal, Golden Keys Award, International Graphic Arts Association, President's Medal, and Westchester County Distinguished Service Award.

Bertrand McKittrick died on March 26 in Boca Raton (Fla.) Community Hospital. He was the third vice president of our class and guest chairman of our reunion committee. He graduated with our class in civil engineering and studied accounting at Lowell Institute. He became president of his family's textile machinery business in Lowell, Mass., after it was incorporated in 1935 as the Frank G.W. McKittrick Co. The business grew and prospered. At the time of his death, Bert was chairman of the board of the company and was nationally known in

the textile and textile machinery industry. Until a few years ago he held the controller's chair of the proprietor of locks and canals on the Merrimack River and also in the Boott Mills complex in downtown Lowell. Bert was a prominent and highly respected citizen of the Lowell area, where he was owner and trustee of the Wyman Exchange Association, member of the board of directors of the Union National Bank, trustee of the Lowell General Hospital, and member of the board, past president, and trustee of the YMCA, where he was a generous benefactor. One of the country's most esteemed members of Freemasonry, he held memberships in many Masonic organizations. At our 55th Reunion, he presented the class with a large fire bell to be used in calling the class meetings to order. Reunion chairmen are to have successive custody, and the names of all of them have been inscribed around the base. Ultimately the bell is to go to the Institute's Museum and Historical Collections.

Owing to the sudden death of **Bert McKittrick**, the nominating committee had to revise its slate: president—**Royal Sterling**; 1st vice-president—**Thomas E. Rounds**; 2nd vice-president—**James A. Pennypacker**; 3rd vice-president—**Thomas B. Drew**; secretary-treasurer—**Richard H. Frazier**; assistant secretary—**Gerald A. Fitzgerald**. Voting on these nominees will be at the class meeting on June 9 in McCormick Hall.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, MA 01890

24 60th Reunion

A review of our 55th Reunion at the Exeter Inn, Exeter, N.H. as described in the August/September 1979 *Review* class notes: 77 took part in the activities beginning Wednesday with an informal dinner. This was followed by a harbor cruise, luncheon, and Pops Thursday, and Friday's seminars and Alumni Association Awards luncheon. Then to Exeter for a lobster dinner. Saturday's banquet and class officers election provided for Sunday auf Wiedersehen. Remember?

Phil Blanchard planned a Sturbridge, Mass. luncheon April 19 with the Fearless Four (**Don Moore**, **Don Fife**, **Herb Stewart**, and **Russ Ambach**) but it was postponed because of a forecast of heavy rain and snow. He suggested a future meeting in Plymouth during one of his trips to his Cape Cod hacienda, come summer. To gather details for our 60th accomodations, the Fearless Four enjoyed a guided tour on May 24 of M.I.T.'s Endicott House and its recent fine addition, thanks to Miss Pierson, the gracious manager.

Our June 1984 60th Reunion may be abbreviated. Thursday, the buffet in the Student Center will be followed by the traditional Tech Night at the Pops. Then our group will move by bus and personal cars to the Endicott House in Dedham for the night. Friday morning, we can attend the Kresge seminars, memorial service, and the annual alumni luncheon featuring class gifts and awards. At 5:00 p.m., there will be a reception in McCormick Hall courtyard with free time afterward. Your entertainment committee expects to have more plans (including Saturday) for the class.

We have belatedly learned of the death of **Russ Robertson** some time previous to April 1981, when mail was returned from Indian Rock Beach, Fla. Little is known of his career. He was awarded an S.B. in chemical engineering, and in 1949 listed himself as a labor union business agent and member of the "Sand Hoggers" Local 88 of the Compressed Air Foundation, Coffer Dam and Sewer Construction Workers, A.F.L. He was a flying instructor and geodetic engineer.

Clarke Williams passed away March 15, 1983 at his home in Bellport, N.Y. after a long illness. A nuclear physicist, he was former deputy director of the Brookhaven National Laboratory. He earned an A.B. from Williams College in 1922, an S.B. from the Institute, and a Ph.D. from Columbia in 1935. His expertise in nuclear physics, gaseous diffusion and related fields contributed to the development of the atomic bomb, a part of the Manhattan Project. He was on the faculty of the College of the City of New York for 19 years, then chairman of Brookhaven nuclear engineering department, being made deputy director in 1962. He was a member of several scientific organizations, Phi Beta Kappa, Sigma Psi, and Sigma Chi.

Phil Blanchard, our class president, writes that he and Besse returned from Florida to New Haven at the end of March after enduring the worst weather in 33 years according to the *St. Petersburg Times*. Attached was a copy of a letter that Phil wrote the *Review* commenting on the article in the April 1983 issue concerning the 100th anniversary of the Brooklyn Bridge.

Allora and **Clint Conway** have moved to North Shore Retirement Center, No. 1101, 939 Beach Dr. N.E., St. Petersburg, FL 33701, (813) 823-1571. Be careful of calling hours!—Co-secretaries: **Russell W. Ambach**, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, 8 Pilgrim Rd., Waban, MA 02168

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Abe Silverberg reports he moved back to the Houston area in 1980 after many years in Mexico. The last 18 years he served as a special consultant and representative for Tenneco, Inc. Prior to that he worked on CO_2 operations with oil wells.

Millard Caldwell reports from Sonoma, Calif: "I have completed two years on the board of management of our adult community of Temelec, with the last year as president. This is the type of volunteer service which I can recommend to all who need an introduction to the selfish, petty motives which apparently fine people will give way to as they try to influence community affairs. But there is a satisfaction in this kind of work which compensates for the conflicts, and now I'm involved in helping to provide volunteer transportation for the area around Sonoma, Calif., in the wine country."

Elinor and **Sam Spiker** spent three weeks in Holland and England during May 1983. Also Sam in a note spoke of the mini-reunion which he hosted in Naples, Fla., and which **Franklin Fricker**, as one of the guests, had reported earlier.

A classmate whom many of you should remember as one of our instructors in hydraulics, **Ken Reynolds**, spent a few days in Chatham, Mass. recently. Unfortunately we weren't able to get together while he visited here with his sister-in-law. Ken came east to attend his granddaughter's wedding in Woodstock, N.H. . . . **Courtney Worthington** and **Ed McLaughlin** joined me at this year's final meeting of the Alumni Council on April 28.

It is with sorrow that I report the passing of four classmates. **John A. Day** died in Jaffrey, N.H. on December 3, 1982; **Henry Doble** in San Francisco in November 1982; **George J. Gross** in Baltimore on January 12, 1983; and **Fred C. Sommer** in Dobbs Ferry, N.Y. on March 11, 1983. No details are available.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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In the previous issue, mention was made of impending 80th birthdays, and we now have this report from **Mark Greer**: "It all started with **Austin Kelly**'s 80th birthday! Austin's lovely wife, Lee, put together a surprise birthday party and we were there, with mementos of Austin's days at M.I.T.—including beaver mascot, sailboat, stein, and pennants. Austin, looking healthy, accepted this tribute with appropriate remarks. **Bird Kelly** was supposed to be there, but couldn't make it. He was missed greatly—after all, Bird was the talkative brother at the reunions. Austin would listen and be the quiet brother. So when *I* was surprise partied, with Austin's presentation of some 40 classmates' good wishes, I was full of deep appreciation for all the friendship from each of you."

In the course of discussing plans with **Dave Shephard** for our mini-reunion, **Don Cunningham** was advised that Dave would be unable to attend due to some difficulties in walking, although he is able to get around at home without difficulty. We will miss our class president very much. . . . A note from **Phil Robinson** tells us of a very active life in consulting since his retirement in 1966, including some in East Germany. He designed a glass bottle plant in Memphis for Underwood Glass, did consulting on glass tube-making in a couple of plants in Mexico, and spent six months in India building a glass tubing plant. For some of us life begins again on retiring!

A long-delayed notice was recently received by the Alumni Office of the death of **Ed Capone** on August 16, 1980. . . . Another notice, just received, advises of the death on May 23, 1982, of **Robert W. Dennis**. . . . **Joe Levis** advised us of the death on May 10 of **Sam Cole**. Sam came a bit late to M.I.T., having served in France with the American Army of World War I. He had been wounded in action at Belleau Woods and received two Purple Hearts, and he was twice decorated by the French with the Croix de Guerre. He participated in the fencing team, of which he was Captain and star performer in 1926. After graduating from M.I.T. he continued his interest in fencing by coaching and aiding our Olympic players. In view of his distinguished military service his burial is to be in Arlington Cemetery.

To compensate for the brevity of these notes I hope to be able to give you a complete run-down of the 57th Reunion in the next issue.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

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The Cardinal and Gray Society, consisting of M.I.T. graduates of the Metropolitan Area having survived their 50th Reunions, met again at the handsome mansion and grounds of Endicott House on May 1. Those '27ers present were: **Fred Byron**, **Dick Hawkins**, **Henry Houghton**, **Ezra Stevens**, and **Joe Burley**. Also present was Ruth Chirurg of Danvers, widow of **James T. Chirurg** who formed the successful advertising firm in Boston. We are pleased to note that Ruth receives the *Review* and reads the news of our class.

In early April **Harold E. (Hal) Edgerton** enjoyed a big celebration of his 80th birthday in "Strobe Alley" corridor outside his office at M.I.T.

His cake was a replica of his famous photograph of a bullet passing through an apple taken with the aid of his strobe light. This and many similar photos Hal has carried in his pocket as calling cards. His exuberance and humor is contagious at any event he attends, and we join in wishing him many more such celebrations.

Charles S. Pope from San Francisco revisited Cambridge in April to help celebrate the centennial of the founding of the Rotch Traveling Scholarship in Architecture. The oldest architectural scholarship in the country has helped many notable architects including numerous graduates of M.I.T. Its history is worth noting. Benjamine S. Rotch, Harvard 1858, from the illustrious whaling interest family in New Bedford, in 1851 moved to a large estate in Milton, cultivated interest in fine arts by trips to Europe, and endowed the scholarship at his death in 1882. His son Arthur Rotch, M.I.T. 1875, formed the leading architecture firm in the country, was influential in founding the scholarship, and left $40,000 to M.I.T.'s School of Architecture. Another son, A. Lawrence Rotch, M.I.T. 1884, conceived plans and constructed Blue Hill Observatory in Milton and pioneered in the measurement of weather phenomena.

In correspondence with **David R. Knox** in Lantana, Fla., I find that since his wife died last year, he has drafted a sequel to his 1971 book, *Portrait of Aphasia*. It is entitled, *Portrait of Grief*, as yet unpublished. Dave has perfected a very human, vivid, and naturally intimate style of prose that is unique. From the prologue—"And when the physical presence of the loved one vanishes, the mutual expression of love is no longer possible. Grief overwhelms

the victim when a loved one is lost for whatever reason." And from the epilogue—"The writing of this manuscript has prompted me to put all my emotions out into the open for all to see and to know. This in inself has been a tremendous healing experience. . . . Awareness of the recovery from grief comes gradually and often results from talking with others."

Alban J. Lobdell, Jr. died on November 18, 1982 in Kirkwood, Mo. He was a chemical engineer with Monsanto Corp. of St. Louis for many years. He was a 50-year Mason. He is survived by his wife Doris, two sons, a daughter, and nine grandchildren. . . . **Francis F. MeVay** died on March 12, 1983 in East Williston, N.Y. He received an M.S. in aeronautical engineering and was a stress analyst with various aircraft manufacturers including Sikorsky and Fokker. At Republic Aviation he was chief structures engineer for 30 years. In 1967 Francis was with Lockheed Aircraft Service at Kennedy Airport. He is survived by his wife Irene, a son, a daughter, and two grandchildren.—**Joseph C. Burley**, Secretary, 5 Hutchinson St., Milton, MA 02186; **Lawrence B. Grew**, Associate Secretary, 21 Yowago Ave., Branford CT 06405; **Prentiss I. Cole**, Associate Secretary, 2150 Webster St., Palo Alto, CA 94301

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These notes are being written only a few days prior to our long awaited 55th Reunion. Since we are at the deadline date for this issue of class notes our reunion report will not appear until next month.

We had an amazing response to our "Thoughts and Sentiments" request—116 classmates turned in their written contributions to the book and thereby earned for each a free copy. The finished book is now a fact. Those of you who did not write a T&S message but would still like a copy of the book can have one by sending in $5 (the approximate cost of production and mailing). Our supply of these extra books is limited so don't wait too long.

We have a letter from **Dempe Dempewolff** in which he suggests that some statistics on the state of '28 class membership might be of interest at this time. The records show that we started out in 1928 with about 900 members in the class. This included recipients of degrees from the graduate school. Nearly all our classmates were men; M.I.T. had very few women students in those days. At present we have a listing of 353 classsmates with known addresses (including four women) and 55 others are listed as living but with addresses unknown. Those known to be deceased number 371, and 121 other members are unaccounted for. So roughly, the indication is that about one-half the orginal Class of 1928 is still with us.

At the M.I.T. Faculty Club in early June, we had a nice chance meeting with **Gus Solomons**. Gus was there with a group of City of Cambridge dignitaries. One of Gus' sons, Gus Jr., '61, a widely recognized choreographer, has his own dance company and was recently acclaimed for his fine performances. Our ('28) Gus and wife Olivia have been effective members of the 55th Reunion committee. . . . A brief note from **Stew Newland** tells us that he and Libby are still leading a somewhat nomadic life by trailering about the country. They wait out the winter months in Florida, then spend the rest of the year traveling about with stops at favorite places and to visit with relatives or friends. This June will see them in Cambridge to attend the 55th. . . . The foregoing will account for one of **Charlie Worthen**'s complaints. In a recent note from Charlie and Velma, Charlie commented on the abnormally miserable weather in California and also mentioned the problem he has had in trying to write Stew. Apparently, Stew's address is wherever he happens to be!

Joe Gaffney wrote that he had some serious surgery during the past year but is now well enough to be at the 55th in June. He finds it hard to believe that he has been retired now for 15 years after 40 years with Sears Roebuck and Co. Five of the working years were given to World War II in U.S. Government service. . . . We have a nice letter with a touch of real romance from **Paul Martini**. Paul was widowed in 1979 but remarried three years later. "Not unusual," you might say—but bride Julia is the girl he had been engaged to 43 years earlier! After parting so long ago there had been no contact for 42 years. Then they met again and were married within a year. True love never dies! . . . After a long interval we have a very welcome letter from Virginia (Mrs. **James A.) Allan**. Despite some health problems, Virginia is well occupied in the busy profession of nursing.

It is with deep regret that we must report the deaths of four classmates. **Harold H. Block** died March 25, 1983. The information was sent by his daughter, Anita Swigart. Harold received his S.B. and S.M. degrees in mining engineering. His professional career remained in mining and metallurgy; he was a consultant and, in addition, managed a family mining business. . . . **Norton M. Case** died on April 25, 1983 in West Falmouth, Mass. His son, Gerald, wrote to inform the Alumni Office and stated that Nort had been with General Electric Co. in Pittsfield, Mass. for 38 years before retiring in 1967. . . . **Nathan C. Norcross** died November 15, 1981, but we have been only recently notified. Nathan studied architecutre, but completed his undergraduate work at Harvard and went on to attain his M.D. degree. His life work was in medicine, primarily in neurological surgery. . . . **Francis H. Rutherford** died April 18, 1983. His nephew, James, wrote to tell us that Fritz died of heart failure after a short hospitalization. He was given a full military funeral at the National Cemetary in Beauford, S.C. Fritz had only just previously sent in his T&S message and had every intention of attending the reunion in Cambridge. To the families of these classmates we offer our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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After driving to Florida for 20 winters, my wife and I decided to have our car shipped by a bonded driver and we took the plane to Ft. Lauderdale, which was wonderful. The return trip did not work so well, as our car was stranded in Florida for over five weeks with all my business and M.I.T. class records, which prevented me from sending birthday greetings to classmates whose dates fall in May.

A few weeks ago, **Jerry Gardner**, our general chairman for the 55th Reunion, who lost his wife Mary recently, came to dinner at our home in Arlington accompanied by Ellie Horwits Zegera, a charter member of our recently organized Widow's Program. Ellie has been a friend of the Gardners for many years. This was a great opportunity to talk about our 55th Reunion next June. . . . **Robert S. Riley** of Middlebury, Conn. writes that he and his wife Margaret are living a wonderful retired life, traveling, skiing, and gardening. Upon graduation, Robert enlisted in the U.S. Army Air Corps Flying School as a cadet. From 1930 to 1946, he worked for Pratt and Whitney Aircraft as a test engineer, project engineer, and field engineer. He also worked for Jacob's Manufacturing Co., Kaman Aircraft, and the Bostich Co. In 1953, he started a new business and continued until his retirement in 1971. He has traveled in Europe, the Far East, Alaska, and Africa. They have eight children and 20 grandchildren.

Louis F. Southerland of Austin, Tex. writes, "Retirement is a happy and busy life for me. My wife and I go to Mexico often as well as trips abroad each year. We are looking forward to attending our 55th next year. Many thanks for the thoughtful birthday cards that keep coming regularly." Louis was a co-founder and senior partner of the architectural firm of Page-Southerland-Page, of Austin, Tex., employing 130 professional men, with branches in Houston and Dallas. The firm has a number of notable buildings to its credit, such as the Supreme Court Building for the State of Texas, Stark Museum of Art, numerous buildings for the University of Texas, Texas Women's University and Southwestern University. He is a fellow of American Institute of Architects; commander, U.S. Navy (retired); and served in World War II. Aside from his extensive travels, he is an avid hunter—big game hunting in the Rockies and birds in Texas, with his own trained pointers. . . . I received a note from **Hunter Rouse** of Sun City, Ariz. saying, "Thanks for your timely greetings on my 77th birthday. We accept with pleasure your kind offer to get us from Boston to Cape Cod next June for our 55th Reunion." Hunter has had a distinguished career in fluid hydraulics, Germany, 1929-33; assistant at M.I.T., 1931-33; instructor, Columbia University, 1933-36; assistant professor, Caltech, and associate hydraulic engineer, 1936-39; professor, University of Iowa, 1939-72; director, Institute of Hydraulic Research, 1944-66; dean of engineering, 1966-72; Carver professor and dean emeritus, 1972. He has written five technical books and 100-odd articles. Aside from traveling, he is interested in lapidary, cuts precious stones by the hour. He has given invited lectures on all continents except Antarctica. He has undertaken technical missions to Egypt, USSR, Rumania, Thailand, Venezuela, Japan, China, Taiwan, and Brazil. He is a member of the National Academy of Engineering and honorary member, American Societies of Civil and Mechanical Engineering.

A note from **John Happel** of Hastings on Hudson, N.Y. reads, "We spent a few days in St. Martin's in the Caribbean in March. It was good to escape the cold weather and the snow, but I ate too much of the good food. We had a dual birthday party for the first time in years. April 1 was my 75th birthday and my daughter Ruth's 25th, so we had a cake with 75 plus 25 equals 100 candles, a lot to blow out! We expect to go to Lake Placid this summer as usual, where I will do some book correcting and later to Paris this fall where I have a project in the joint U.S.-France science exchange program. I hope they will give my French colleagues money to travel to the U.S. in spite of President Mitterand. My wife Dottie and I hope to attend the 55th Reunion next June. One of my former students at New York University, Howard Brenner, is a professor in the chemical engineering department at M.I.T. now." Most of John's professional career has been connected with chemical engineering and research in that field. He was associated with Mobil Oil Co. where he jointly was responsible for design and initial operation of the world's largest butadiene plant for synthetic rubber. He was chairman, Department of Chemical Engineering at New York University, where he directed research of 75 graduate students and published over 100 technical papers and authored books on chemical process economics, hydrodynamics, and catalysis. He is president, Catalysis Research Corp. which he organized to do research in the area of coal utilization and environmental protection. He is also adjunct professor and senior research associate at Columbia University and vice-president of New York Academy of Sciences. His hobbies include hiking in the Adirondacks (where he spends summers at Lake Placid), tennis, and gardening. He has traveled most of Europe, Japan, Russia, and the Caribbean.

June 10 Technology Day had more than average attendance by the Class of 1929. A whole table was reserved for '29ers. Those who attended were: **Arthur Bearse, Putnam Cilley, Karnig Dinjian, John Rich** and wife Olive, and **Gordon Williams**. Arthur and Put have been close friends and have attended Technology Day regularly for many years. Gordon was a hydraulic engineer engaged in water resources development (irrigation, flood control, and water supply) in about 25 countries in South America, Europe, Africa, and Australia. He was a professor of hydraulic engineering at M.I.T. from 1953 to 1960. John was associated with Improved Machinery, Inc. Nashua, N.H., (division of Ingersol-Rand Co.) manufacturer of paper pulp and plastic, starting as a draftsman, engineer, sales, assistant to the president, and landed on the top position as president until his retirement in 1971. John and Olive have been close friends with **Bill Baumrucker** and wife Doris and **Tom Speller** and wife

Helen, with whom they have gone on vacation trips for many years.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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Assisting Lucilla and **Bill Jackson** to celebrate their 50th wedding anniversary in Manchester, Mass. in June 1981 were **Jack Bennett**, **Wally McDowell** and **Virgil McDaniel**. Bill is board chairman of Pittsburgh-Des Moines Corp. and serves on bank and hospital boards in Pittsburgh. . . . Maryann and **"Yicka" Herbert** are still travelling extensively. They have twice taken delivery on new cars in Germany, driven them for a while and then had them shipped home (a Mercedes station wagon in 1981 and a BMW this year). Yicka sees **Tom O'Connor** frequently at the Charles River Country Club, where they are both members, and occasionally sees **Ernie Fell**, **Ed Pritchard** and **George Wadsworth**.

In the information form that **Wally Hope** returned to me he complained that he never finds anything in the Notes about his Course XIV classmates. Wally promises to "needle" them, and we should soon have a flood of items about those who graduated in Course XIV. . . . **Louise Hall** sent me a quote from a Wellesley alumni publication reporting that **Margaret Surre Wilbur**'s husband Donald is an expert on Iran and that the Princeton University Press has recently published a 9th edition of his book *Iran Past and Present*. . . . **Robert Nance** entered M.I.T. with our class but discovered by the end of his first year that he did not want a career in science or engineering. His business life has been spent in investment brokerage and later in the sale of educational materials—"a large line of maps, charts and biology items to school systems." However, his main interest is in the arts, particularly instrumental music (he plays the saxophone, cornet and trumpet), portrait photography, and motion picture techniques.

It is regretfully necessary to report the deaths of three of our classmates: **Ted Dourdeville** in September 1982, **Juel Lensch** in December 1982, and **Worthen Taylor** on March 24, 1983. The only information I have about Ted is that he was a longtime resident of Jefferson, Mass. and at one time was engineering vice-president of David Gessner Co. of Worcester. . . . **Juel Lensch** worked for the U.S. Corps of Engineers for 35 years and retired in 1975 as branch chief of the South Pacific Division. At the time of his death he and his wife Gladys were living in Orinda, Calif. . . . **Worthen Taylor** worked for the Massachusetts Public Health Department for many years. At the time of his retirement in 1967 he was director of the Division of Sanitary Engineering—the chief sanitary engineer of the state, dealing primarily with water pollution problems. After retiring from his state job, he joined the Federal Water Pollution Control Commission where he worked on the development of water quality standards at the Northeast Regional Office. At the time of his death he lived in Newburyport. He is survived by his wife Alice, his mother, two children, two grandchildren and two great-grandchildren.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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Your assistant secretary **John Swanton** reports his attendance at the Cardinal and Gray Society meeting at Endicott House on May 1, 1983. As you may know, this society consists of senior members from the New England Area (members of classes graduating 50 years ago or more). It was a new experience because we have just joined the 50-years-or-more classes. John regrets that he didn't take Louise along and reports that Professor Bloomfield gave an excellent talk on government and world problems. Classmates who attended the meeting included Mary and **Eugene Branca**, Polly and **Ken Germeshausen**, Gertrude and **Lou Hesselschwerdt**, Kay and **George Manter**, Frances and **John McNiff**, Mildred and **Charles Seaver**, **Maddie Cannon**, and **Laura Damiano**.

Larry Barnard visited Longboat Key again this year with Jan, after a visit with Jan's sister on Marco Island and several days in Disney World and Epcot. Helen and I were sorry that we couldn't get down to see them this year. . . . **Bill Hallahan** reports that he retired as senior vice president and treasurer of Fay, Spofferd and Thorndike, Inc., in December, 1982, and remains as director and consultant—which requires very little effort. . . . Elenor and **Joe Buswell** spent the Christmas Holidays on Maui, Hawaii, and plan to go on the Mini-Reunion cruise to Alaska. They spend about half the year in Sun City, Ariz. and the other half near Kingston, Wash. They leave for Washington on April 25. They also had an interesting Tauck Heli-hiking trip to the Cariboo mountains in British Columbia last September which included 10 helicopter rides to glaciers, mt. meadows, and ridges.

Joe Brennan

Since reporting the death of **Joe Brennan**, in Alexandria, Va., on November 5, 1982, we have received the following additional information. He was employed as a civilian engineer for over 20 years with the U.S. Army Corps of Engineers, first in Los Angeles, and later as chief of the Project Planning Branch, Civil Works Division, Office of the Chief of Army Engineers in Washington D.C. In 1957, he became the staff engineer consultant to the Committee on Public Works, U.S. House of Representatives. He retired from the Committee in 1968 and was a private consultant until his death. . . . Regretfully, we also report the death of **Richard O. Mason**, the senior partner and founder of his patent firm. He died in his Tucson home on November 18, 1982.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mt. Dora, FL 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben Steverman**, Assistant Secretary, 8 Pautucket Rd., Plymouth, MA 02360

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We all had high expectations of seeing Maria and **Jim Serrallach**, this June at our 51st Reunion in Cambridge. However, we have just learned that his doctor does not consider that he is ready for such a trip yet. However, he hopes to be with us next year. He would like very much to hear from his classmates. His home address is Pasaje Maluguer 11, Barcelona, Spain. . . . Rebecca and **Arthur Marshall** have just celebrated their 50th wedding anniversary. Arthur had a bad bout of bacterial pneumonia this past winter. After a slow recovery he is about to embark on a trip to Israel. . . . **George Kerisher**, our class treasurer, has submitted the financial report of our 50th Reunion. One hundred fifty-four members paid $25 class dues, totalling $3,850. This practically covered all the expenses of a great reunion. Write to George if you would like a more detailed report. . . . **John Strickler, Jr.** writes that he has stopped working on windmills and is now working on a dual-powered car. We'd love more details, John.

Although retired from active business management, **G. Robert Klein** is involved in a number of distribution businesses as an investor and management consultant. He and his wife Mary Elizabeth have taken a number of three-week trips to faraway places including Russia, China, the French Riviera, Spain, South America, the Middle East, Iran, India, and Nepal. What a travelogue you could give us! . . . In May, **John Brown**, **Al O'Neil**, and I participated at the M.I.T. Telethon. We helped the Alumnni Fund complete it's 1982-1983 drive. . . . **Donald Walden** had been 32 years with General Electric. He is now part-time gardener and florist. His son and two daughters are all professionally engaged in interesting careers. . . . **Donald Morgan** is retired. He and his wife Vivian keep busy with church work, gardening, bowling, and traveling. They have four children and four grandchildren.

The mail has brought me several obituary notices. It is my sad duty to pass them on to you.

Albert A. Stewart died after a brief illness at his home on February 24, 1983. Until 1978 he was a professor of mechanical engineering at Southeastern Massachusetts University. He was an engineer at Pratt and Whitney before serving in the navy during World War II. He was active in Fall River and Westport community life, especially in church, M.I.T., and art organizations. He is survived by his widow, Clara. . . . **Addison S. Hall** died on February 22 after a long illness. He was a retired fire protection engineer. During the war he was a lieutenant in the navy aboard the *U.S.S. Bowditch*. He was active in church affairs, yacht clubs, Boy Scouts, and professional fire fighting organizations. He is survived by his wife Ivey, a daughter, and two grandsons.

Robert Baschnagel died in September 1981. He retired in 1975 as vice-president of his company. He is survived by his wife Dorothea, a son, and a daughter.

Alfred W. Halper died on March 17, 1979; **William I. Stieglitz** on December 10, 1982; **Alfred Reidell** on March 5, 1983; and **Frederick P. Fay** on October 23, 1982. He is survived by his wife Mary.

When we get further obituary information, we will pass it on.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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In May all signs pointed to a great 50th Reunion with many old-timers and lots of first-timers attending. If there is money left, someone will probably write a full report and mail it to all of us.

Reading what reports we have in hand it seems some of us are really active—sailors, skiers, hikers, gardners, fishermen, a few workers and even one woodchopper, **Stan Walters**.

Carl Swanson sent us notice of the death of **George Huff** but nary a word of himself. . . . **Larry Parsegian** is deeply concerned about things nuclear, saying we haven't done much to make things better for the next generation. He collects pictures of early Armenian architecture. He says "in my approaching old age"—go 'way, Larry!

You fellows did rally round for the reunion gift to the Institute. **Dayt Clewell** says, "Thanks to all." There is still time to include M.I.T. in your estate planning. Write Neil Didriksen at the Alumni Office for information.

Warren Henderson says 20 years as secretary shows him it is impossible to keep all the information that comes, so I'll discard your letters after two issues. Do come through now with news.

Cooper Cotton who hasn't been back to the Institute since 1933 retired in 1981 and now has time to cut grass and play golf with Mary. . . . **Jim Norcross** retired from the electrode business ten years ago and set up a consulting business for home owners, which keeps him busy.

There have been notices of the passing of **George Huff**, **John W. Powers, Jr.** in 1979, **Steven J. Alling**, **R. Barlow Smith** in 1980, and **William A. Soley**.

Fred Murphy, our president; **Westy Westaway**, our perennial reunion chairman; **Dayton Clewell**, our gift raiser; **Warren Henderson**, our secretary, and **George Stoll** our treasurer, all served us well in this historic year. . . . **Ed Atkinson** (Amherst, Mass.), who was in the dyestuffs business, says the story about Althouse Chemical in the April issue wasn't 100 percent correct, but it will do. . . . Who

was that man down at the Cape who was having such a good time he wanted to make reservations for our centennial?

With that we'll quit and tell you we have a new print-out of names and addresses. If you need any, just write. The price? A bit of news about yourself or a classmate.—**Beaumert Whitton**, Acting Secretary, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210, (704) 553-0515

34 50th Reunion

Your secretary **Bob Franklin** is (at this writing) on a trip to England and France. His assistant now buckles down to work. It is a pleasure to report that Father **John Hahn** has received a special award from the Catholic Press Association for the best article in Spanish. It is called, "A Struggle for a New Destiny" and was published in the Spanish edition of the *Maryknoll Review*.

It is also a pleasure to report on my travels, because they involved a very fine four weeks with Maureen and **Arthur Manson**. We met at Kennedy Airport and flew to Madrid. From there we took local excursions to Toledo and to Franco's Valley of the Fallen. We then rented a car and drove up into France to visit Carcasonne, Avignon, and Nimes with its great three-tiered Roman aqueduct, the Pont du Gard. Then back into Spain and the pilgrimmage center of Santiago de Campostella. Then south through Avila and Segovia where another great Roman aquaduct runs right through the center of town. South to Andalusia with Cordova and Seville where I had a haircut, but did not ask the barber if his name was "Figaro." Before flying home from Malaga, our last stay was in Grenada with the Alhambra. There we saw how our fellow American, Washington Irving, with his *Tales of the Alhambra* had made the Spaniards realize the treasure they had and caused them to maintain the beautiful old Moorish palace so well.

Herbert Andrews reports he has just visited his great-grandaughter whose parents are with the U.S. Air Force in Bitburg, Germany. . . . **Eugene Magenau** writes, "My architectural training and practice were good preparation for retirement. Recent projects include a bedroom and bath addition and assisting with computer installation in my son's office (Yonex Tennis Rackets). But mostly I keep busy on do-it-yourself projects and tennis." He concludes on a note of searching for other super-seniors.

We now have more information about **Israel "Skee" Nigrosh**'s distinguished career. He lived in Belmont for 42 years and designed many homes, commercial buildings, and temples in Newton and Worcester, as well as the one in Belmont where services were held for him. His designs have appeared in several national magazines. He served for many years on the town's planning board and park commission. He is survived by his wife Frances, two sons (Leon I. Nigrosh of Worcester and Dr. Barry J. Nigrosh of Northampton), and a granddaughter. . . . On May 30, 1981, **Ted Hertzel** passed away. There is no further information. Some of you (like myself) remember playing soccer with him. . . . Rear admiral **James M. Robinson** died March 29. He graduated from the Naval Academy in 1925 and later earned a master's at the Institute. He received many military decorations including one from the British. After retiring from the navy in 1955, he joined RCA as a project manager, from which he retired in 1969. He continued to serve as a consultant.—**George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20015; **Robert M. Franklin**, Secretary, P.O. Box 1147, Brewster, MA 02631

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The mini-reunion organized by **Philip Johnston** was held at the Brandywine Museum in mid-May with ten '35ers and wives present for a tour of the Museum, cocktails and a light repast, and much socializing and catching up. Class members who attended were **Hal Bemis**, **Bill Brockett**, **George Bull, Jr.**, **Bernie Freiberg**, **Phil Johnston**, **Herb Thomas**, **James Libby**, **Norris Ruckman**, **Spencer Carpenter** and **Ed Edgar**. **Leo Dee**'s proposed gathering has been put off until fall.

Samuel P. Brown has been elected to the board of directors of the Brooklyn Union Gas Co. Sam writes, "We have sold this too-large house and are moving to the Poconos, and then in the fall, down to our new condo in Florida. We've joined also Burnt Store Golf Club in Ponta Gorda where we played the last two winters; it is a nice club and a good golf course—just 1 3/4 miles from our home there." . . . **Maxwell P. Lewitus** sent the following short note through the Alumni Office: "We are now settled in our 'Villa' in Boynton Beach, Fla., after spending six months of each of the past 15 years in Guadalajara, Jalisco, Mexico." . . . **Les Brooks** wrote in late April lamenting the depressing no-sunshine weather in Georgia and the unseasonable late frost that turned all his hard work in his vegetable and flower gardens into varying shades of brown and yellow. Then he goes on, "But all of this will be forgotten by tomorrow when two of our daughters and three grandsons from New York and Connecticut arrive for a week's visit. We're quite excited and have a full week planned if we don't fall apart half-way through. We are fine, although Ellen has a bit of recuperating to do yet after surgery in February."

Frank Hatch reports from Burlingame, Calif., "I'm still busy with Rotary (as secretary of the San Mateo Club), wine-making, track meet officiating, occasional furniture-making and ASME. I'm history and heritage chairman of the San Mateo County section, and we were awarded an ASME historical landmark for the Archimedes screw pumps which pumped brine in the San Francisco Bay salt ponds some 90 years ago." . . . **Ted Pomeroy** wrote a short note from Cooperstown, N.Y.: "We are just back from visiting our daughter in Brunswick, Ga., where we enjoyed sunny beaches on Jekyll and St. Simons islands. We hoped to come back here for spring and flowers, but alas we are still in the snow."

A note from **Mort Rosenbaum** in San Diego: "I'm all charged up for golf after being off the course—due first to the flooded condition and second to a broken ankle received on the course last November. However, I'm all healed now and the course is playable again." . . . **Wes Loomis** writes, "Even though I still belong to the Glen View Golf Club in Illinois and the Longboat Key Club here, I have not swung a golf club for two years. So I think you'd better count me out again this year. We are driving back to Kenilworth for the summer and I just may try and put it all together again and see what I can do with my posted 27 handicap. **Pete Grant** and I hoisted a couple yesterday. We both seem rather fit." . . . **Bill Parker** wrote to me from Bella Vista, Ark., that he and Marjorie had no plans to go East this summer as they were entertaining at home. In the process of winning the Cup in our 1979 Class Golf, Bill's handicap dropped to 20, but with the wet weather he has not been able to play close enough to it for his peace of mind.

James W. Libby was another of my correspondents who took advantage of the SASE's I sent out with the Golf Entry Forms; he writes from Hockessin Del., "Your efforts towards improving Class of '35 communications are really paying off. You may recall that you were instrumental in relocating **Rollin Morse** for me. As a consequence Helen and I visited him and Virginia in Columbia, Pa., recently and had a personally conducted tour of the town, the older parts of which Rollin is working hard to have placed on the National Historic Monuments list. I can report that he is in fine shape. On a Swampscott note, we had a family reunion at Alice Libby Junker's in Schenectady with Mary Libby Parker and their husbands, including **Jim Parker** of our Class. Although we had lots of rain, we had a great time."

Back in early April, **Ed Taubman** wrote me a long letter which arrived just too late to include in last month's notes. Here it is: "Perhaps I'm a little early with my five-year letter description of life's events, but in view of a very pleasant recent visit to India, I decided to mention details of this as they may be of interest to other classes. Back in 1939, several years before Cele (my wife) and I met, her cousin, Frank Libman, '40, was an M.I.T. undergraduate whose roommate, S.B. Pattani, '40, an Indian student, usually spent school holidays with him at his New York City home. He dated Cele occasionally during this period and they became rather good friends. Last year, just prior to a contemplated tour of India which we had to cancel due to a kidney stone problem of mine, she wrote him at his last address shown in the 1975 Alumni Register. He answered, and we would have met in Bombay had our trip gone through. This year we finally made our trip and "Pat" met us in Bombay on March 14. He also very kindly arranged a later afternoon tea meeting with other local M.I.T. graduates: Mansukhial D. Parekh, '38, Bhagwan D. Toshniwal, '39, Baboobhai V. Bhoota, '40, Shantaram M. Dahanukar, '39, and Shashikant B. Pattani, '40. Several of the men brought their wives along and Cele and I had a very pleasant talk-fest. The group had ordered native hors d'oeuvres that were delicious and unlike anything we had eaten before or since. As you can imagine, these men were highly successful in their careers and of the upper strata of their society."

It is now my sad duty to report to you the deaths of six of our former classmates: **Julian P. Perry**, died in Holicong, Pa., on January 10, 1983; **Donald A. Morrison** of Butler, Pa., died February 24, 1983; **John Thorpe** of Chappaqua, N.Y. died February 26, 1983; **Thomas C. Donnahue** of Alexandria, Va., died March 18, 1983; **Thorne W. McWhood** of Ramsey, N.J., died April 4, 1983; **Alfred McDonald** of Orleans, Mass., died April 11th. I am sending expressions of sympathy to their widows and families on behalf of the Class.

Ten members of our Class attended **John Taplin**'s May 25 meeting of the 50th Reunion Gift Committee: **Bissell Alderman**, **Leo M. Beckwith**, **Phoenix Dangel**, **Edward Edgar**, **Robert Forster**, **Allan Mowatt**, **Bernard Nelson**, **Walter Stockmayer**, **John Taplin** and **David Terwilliger**. Much progress has been made but we still have a way to go to meet our goal.—**Allan Q. Mowatt**, P.O. Box 92, Newton, MA 02195

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At the memorial service in the chapel on Technology Day seven members of our class were listed. Three I have already reported to you: **Norman A. Cocke, Jr.**, **Benjamin Cooperstein**, and **John B. Hayes**. Herewith as much information as I was able to glean from the Alumni Records Office on the others. **Sebastian Mazzotta** died in September 1982. He was for many years President of MA&M, Inc., general contractors in Middletown, Conn. He leaves his wife, Gertrude, who lives at 5 Mazzotta Pl., Middletown, Conn, 06457. . . . **John A. Meeks**, a graduate member of the class, died in July 1981. He taught physics at the Citadel in Charleston, N.C. . . . **Stanley B. Smith** in June 1981. He had been with Bendix in South Bend for years and in the most recent alumni directory was listed as general manager, Bendix Energy Controls Division. . . . **Lea Spring** in June 1982. The information was supplied by the bookkeeper of the Spring Gravel Co. in Crookston, Minn. I have no other information.

At the luncheon following the memorial service, I sat with Rosalie and **Jack Chapper**, Rose and **Ed Dashevsky**, and Florence (Mrs. **B.**) **Cooperstein**. It was reported that **Leo Kramer** had been at Pops the previous evening as had **Bill Metten**. Lillian and **Larry Peterson** were on the planned-to-attend list but I did not see them. **Herb Borden** had previously written to explain that for the first time in many years he would not be present because he would be sailing in the Off-Sounding Races in Long Island Sound, an event in which he has participated for many, *many*, years." He went on to say that he would get on the ball with his 50th Reunion Gift prospects, hoped to see us all in West Hartland in October, and would help in any way he could with

the 50th Reunion. Any more volunteers?

John J. Hibbert noted with his contribution to the Alumni Fund that he had retired in 1980 from the Bell Telephone Laboratories and that he and his wife Harriett had moved to Midlothian, a suburb of Richmond, Va. He says, "All nine children have left home and are married with a total of ten grandchildren, so far. After M.I.T. graduate study at Harvard, Radiation Lab (M.I.T.) 1941-46, then to BTL for nearly 35 years (always in challenging technical work). I am very grateful to M.I.T. for making it all possible. Hope to make the 50th Reunion."

Meanwhile, there will be a mini-reunion in West Hartland on Saturday, October 29. Get in touch with Mary and **Fred Assmann** if you are interested in coming (17 East Curtis Ave., Pennington, NJ 08534), or at the last moment call me at (203) 379-3807.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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Joseph S. Dunning, 7537 Mulholland Dr., Los Angeles, CA 90046, retired from McDonnel Douglas Co., Inc. as vice-president, administration. Currently he is semi-retired and consulting. His hobbies are civic volunteering, photography, and golf. He is currently serving as a member of the M.I.T. Visiting Committee and the Long Beach Hospital Board. Wife Vivian's main interests are the County Art Museum and church. They have three grandchildren Dianna, Joshua, and Ananda.

I regret to report the following deaths. **John L. Everett** died of cancer March 20 at the Hospice of Northern, Va. He retired from Arthur D. Little as a senior research analyst in 1979 where he had worked since 1969. He is survived by a son David of Falls Church, Va., and daughters Carol T. of Washington D.C. and Sall Beaupre of Bern, Switzerland. **Alvin J. Garber** died February 10, 1983. He is survived by his daughter Stephanie Garber, 16409 Hutting Pl., Silver Springs, MD 20902. . . . **Louis H. Laforge, Jr.** died April 17, 1978. He was survived by his wife. His last address was 1461 Ascension Dr., San Mateo, CA 94402. . . . **Philip Short** died December 28, 1981. He is survived by his wife.—**Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary 506 Riverside Ave., Medford, MA 02155

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Donald MacDonald reports that he was unexpectedly promoted to office director in the Department of State. He plans to leave government service at the end of the year to join the faculty of Georgetown University. . . . **Arch Copeland** recently returned from Thailand, where he had family. . . . **Bill Whitmore** retired in February from Lockheed Missiles and Space Co. and immediately reported back to work "on call" for half-time.

Strange how you find out things: I had a note from Bill Haynes telling me that he had seen my father play in the Worchester County Tennis tournment several times in pre-M.I.T. days. . . . **Ann Mowatt**'s husband Allen, secretary of the Class of 1935, turned over a report that Ed Taubman, '35, had seen **Mansukhial Parekh** recently in Bombay, India. . . . **Fred Reuter** visited **Rudi Herrera** this spring in Guatamala City. Rudi is Guatamala's most famous surgeon, grows coffee and sugar on his plantations, and flies his own jet helicopter.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

39

Olive and **Tom Blakistone** now live in rural splendor at their DelMar hillside home. Olive directs and produces plays for a new Little Theater, and Tom starts his third career, this one as an impresario. Tom's first successful career was in high-technology business, and he owned and sold some companies. Tom's second business was to stimulate international and domestic groups in seminars to develop psychiatric strategies for problem solving. Now Tom is underwriting a Little Theater. Hilda and I joined Tom and Olive for a delightful dinner in their home and at their North Coast Repertory Theater later, where they were presenting "Arms and the Man." . . . Billie and **George Cremer** were among 200 pioneers who produced prestigious results at Los Alamos and who reassembled for an April reunion, with reminiscing and idea-exchanging. Dick Feynman shared speechmaking with other famous physicists. . . . Allan Mowatt, 1935 Class Secretary, kindly relayed the news that his classmate Ed Taubman had visited Bombay, India, where he was cordially welcomed at afternoon tea by two '39ers named **Bhagwan Toshniwal** and **Shantaram Dahanukar**.

James S. Bruce retired as senior vice-president of Eastman Kodak after 43 years' service. . . . In retirement Jim is enjoying some consulting, lots of golf, tennis, backpacking, and a tour to China. . . . **Albert C. Waters** retired from full-time assignment as project manager for expansion of the Riyadh International Airport and now works part-time as a building inspector at Topsfield, Mass. . . . **Bob Schmucker** generated extraordinary news by announcing that he is *not* retiring! Bob continues his fascination with the metallurgy and manufacture of permanent magnet alloys, and this stimulated him and Jean to relocate to Indianapolis. . . . **Bill Mohlman** reports completion of his chemical engineering process work on the Alaska Pipeline and commencement of studies to determine feasability of extracting petroleum from deposits of diatomaceous earths. Bill makes his home now on a beautiful hilltop in Rancho Palos Verdes where he can look southward to see Marineland and the Pacific Ocean below.

We are saddened by the deaths of two classmates: Dr. **Joseph Coffey**, professor of Chemistry at St. Louis Community College, died July 20, 1981. . . . **C. Barrett Campbell**, recently of Pacific Grove, Calif., died January 6, 1983.—**Hal Seykota**, Secretary, 1603 Calle de Primra, La Jolla, CA 92037

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Dick Braunlech writes that he retired from FMC Corp. in December 1980 and has been very active in Vero Beach, Fla., cultivating fruit trees, competing in senior tennis tournaments, playing violin and guitar professionally, and operating two sport fishing boats in Indian River and offshore in the Atlantic Ocean. Best years of his life! . . . **W. H. Krome George** retired as chief executive officer of Aluminum Co. of America on March 31. He will remain as director and chairman of the executive committee. . . . Copy of an interesting letter sent to me by Allen Q. Mowatt, class secretary '35, describes a trip to India by one of his classmates and wife and his tea hour meeting with local M.I.T. graduates in Bombay. Dr. **Baboobhai V. Bhoota** and **Shashikant B. Pattani** were present. Time together was all too short, even for reminiscing about Tech days, much less the many questions about Indian affairs. These men have been highly successful in their careers and quite influential in their fields. . . . A note received from the Alumni Office indicated that **Arnold Arch** died at his home in Pittsburgh, Pa., on March 31. He is survived by his wife and daughter.

I. M. Pei received the 1983 Pritzker Architecture Prize. This is called the Nobel Prize in architecture and was established in 1975 because no Nobel for architects existed. The award includes $100,000, tax free, and a bronze sculpture by Henry Moore. In addition to the Kennedy Library and the West Wing of the Museum of Fine Arts in Boston, his projects include the Fragrant Hill Hotel, Beijing, China; East Building, National Gallery of Art; Dallas City Hall; Oversea-Chinese Banking Corp. Center, Singapore; National Center for Atmospheric Research, Colorado; New York City Convention and Exhibition Center; and the Dallas Concert Hall.

Dick Falls retired in July 1982 and in November he and his wife, Marjorie, took a cruise around the Hawaiian Islands and went on to spend almost three months visiting his wife's sister near Melbourne, Australia, and sightseeing up to the barrier reef in North Queensland. Dick reports he now has seven grandchildren! Can you top that?

Please keep the news coming!—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

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Herman A. Affel, Jr. has been chairman and chief executive officer of Computer Consoles, Inc., Rochester, N.Y. We would like to get a better story from him. . . . **George H. Palmer, Jr.** has finished 32 years building ships with the American Bureau of Shipping on the Great Lakes. He is presently based in Cleveland and has promised to send more details. . . . **Joseph Gavin**, President of Grummon Aerospace was a keynote speaker of the Electro 83 "Tomorrow's Technology Today" in New York. . . . Urgent message from Cape Cod: *Send a small note of information about yourself*.—**Joseph "Zep" Dietzgen**, Box 790, Cotuit, MA 02635

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An unusual announcement from **Bob Howard**: During April he had a mastectomy. He claims that he is probably the only member of our class—females notwithstanding—who has had breast cancer. He is recovering well from the surgery, and fortunately there are no after-effects.

Shep Tyree says that he is approaching retirement with some anticipation and will have at least two address changes during the next 12 months. Shep has been a professor of chemistry at William and Mary. He started his academic career at M.I.T., getting a Ph.D. in course V, and then in 1946 going to the University of North Carolina at Chapel Hill to start as an assistant professor there. As Shep puts it, he stayed at U.N.C. for 20 years with "two years off for good behavior" and has been at William and Mary ever since. Shep has taught or researched at Oak Ridge National Laboratories, Colorado State College, the University of Puerto Rico, and the Washington and London offices of the Office of Naval Research. Certainly a varied and interesting mix.

W. H. (Heinie) Shaw is still active with the National Ski Patrol doing some mountaineering and first-aid instruction. This note came about a month ago; by that time Heinie had already spent 40 days in 1983 skiing locally, at Monmouth Mountain, Aspen, and Squaw Valley, and in Austria. He also reports that his 10-year-old book on diving is still selling well—the royalties are like an annuity. . . . **Doug McConnell** still lives on Monterey Bay in California and is active in local community affairs there, as president of the Homeowner's Association and member of the board of the council of Approvement Associates and of the Associates of Good Government. They're working on some reasonable energy programs for Santa Cruz County.

In an April letter, **R. S. (Hawk) Shaw** reports a very wet and muddy spring in New Hampshire: "We remain here in New Ipswich, N.H. and dabble in the mud of our making. Some of it was here before and is a wonderful useful variety. Dublin Lake is said to be the crater of Mt. Monadnock and remains unexplored. The ecologists jealously guard the mud at the bottom 400 feet or more down. Fuller's Earth is its name. We have invented a monster more frightful than that guarding **Bob Rine**'s Loch Ness—even better ones guard New Ipswich and its richness." . . . A job took me to Erie, Pa., a couple of weeks ago and I had the good fortune to have breakfast with **Pete Volanakis**. Pete is still holding forth as president of Hammermill Paper Co. His hair has turned completely white, but he looks as though he is not more than a few pounds different from his wrestling weight back in 1941! Pete and Freda have three grown children: three boys and a

girl. Their daughter has presented them with a couple of grandchildren thus far. All is well with the Volanakis clan.

Our class was well represented at the M.I.T. Symphony's Carnegie Hall concert on April 24, including the **Bob Greenes**, Rhoda and **Alan Katzenstein**, Francine and **Jim Stern** and Jean and me.—**Ken Rosett**, Secretary, 191 Albermarle Rd., White Plains, NY 10605

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Robert W. Beatty reports, "I'm retired since 1974." . . . **Ken Wadleigh** has resigned as M.I.T. vice-president and dean of the Graduate School, effective the end of the 1982-83 academic year. After a year's leave, Ken will return to the mechanical engineering faculty where he began his career as a teacher 37 years ago. I'll not repeat the newspaper's detailed account of Ken's career, but it should be enough to say that his administrative duties will be reassigned to four other faculty and staff members.

There are two deaths to record: **Forrest S. Pearson**, June 17, 1981, last address Benton Harbor, Mich.; and **Gilbert S. Graves III**, some time in 1982, last address Evansville, Ind. We have only the bare bones of these announcements, with no word about lives, careers, or families.

The 40th Reunion should generate lots of news, and I'm looking forward to seeing many of you there.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44 40th Reunion

Ken Rehler reports that he is "doing a very small amount of computer consulting, still very active buying and selling houses for my own account, and planning to retire from the above in late 1984 to travel and to whip grandchildren into shape." . . . **Edward L. Klopfer** notes that he is operating his own company, Edward L. Klopfer, Inc., primarily in the field of solar applications of HVAC solar equipment for both residential and commercial buildings.

On May 21, **Peter Matthews** attended the 7th Annual Solo Competition of the Oratorio Society of New York at the Carnegie Recital Hall where his daughter Andrea won first place in the competition. . . . The updated home address for **Richard H. Hinchcliff**, who is executive director with Regular Common Carrier Conf., is 6958 Kyleakin Ct., McLean, VA 22101. . . . **Paul Heilman** went to California in April and spent some time visiting with M.I.T. alumni. Paul is marketing and sales manager with Bridgeport Brass Co.

Hugh Parker, '43, wrote me of the death of **Peter S. Hopkins**, which occurred sometime in April. Peter had been in declining health for some time and it was a massive heart attack which ended his life. . . . On page 82 of the May issue of the *Chemical Engineering Progress*, under obituaries: "**Howard Weaver, Jr.**, 60, who was retired and living in Pampa, Texas, died recently." . . . **Douglas B. Smith**, who did graduate work at M.I.T. and was a project officer in the Far East section of the Export-Import Bank until his retirement in 1980, died on March 27 of cancer at Sibley Memorial Hospital. . . . **Bertram Paul Schmitt**, formerly of Glenside, Pa., died in June 1982. We extend the sympathies of the class to the members of the deceaseds' families.

Andy Corry and guest, Jane and **Lou Demarkeles, R. J. Horn**, Janice Kispert, Joe Martori, Ruth and **Norm Sebell**, and **Melissa Teixeira** met in May at the home of Anita and **Les Brindis** for dinner. Andy conducted the business part for the gathering, at which time the chairmen for the 40th Reunion committees were selected. By now you should have received a publicity notice of the reunion activities. Hope that you are planning to return to the Boston area for our 40th reunion which takes place in Cambridge and Newport, R.I., on June 7 to June 12.—**Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165

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Just as I was up against the May 31 class news deadline and in the final throes of packing for our big trek East, didn't I get the craziest, James Joycean, stream-of-consciousness letter from our free spirit, **Bill Cahill**, living in sinful Incline Village. It's reminiscent of **Stu Edgerly**'s monologue about his kids at our 35th Reunion clambake. For a reprint of Bill's letter, send me a self-addressed-stamped envelope.

He writes to me: "Dear Knobby, (my V-12 moniker) . . . I've come to the inescapable conclusion that '46ers are as a class a flock of 'functional illiterates' [my words] as my predecessors, **John Maynard** and **Russ Dostal** found out." However, I'm just stubborn enough to stick it out. So just as Chief Reese used to say, "Just a little *pre-warning*!"

But back to Bill's odyssey. Here he is, an unemployed, overweight, pre-social security case, full of wisdom about the human condition—including his own—living in mild chaos on the shores of Lake Tahoe. Lord knows how he came to be there, but he has managed to survive, with wife Shirley, eight sons, and three daughters, over the decades of their marriage, with some precarious degree of sanity. Last fall they managed a trip back to the "olde sod" for some golf and nostalgia, discovering that Irish Cahills "are not landed gentry, respected doctors, philosophers, bankers, or politicians, but (rather) race track bookies, bartenders, or used car salesmen, a fact we suspected but wished to confirm."

Upon their return to America a litigation award from Sears "with lots of zeros" allowed them a trip to Hawaii last December for a potential sailing odyssey. But heavy weather convinced Bill that this was not part of their karma. Back to California and the beautiful Sierra scene, Bill discovered that he is the grandfather of "white, black, and yellow" grandchildren from No. 4 son; youngest son had pulled a quadruple 360-roll in a friend's Blazer (somehow surviving); two sons, Mike and Kevin, with law degrees, extricating Bill from cheating partners and involvements in Big Bucks in Big Sur property; sons Court and Tim in some interesting ("Sensimilla") agriculture in Eureka, Calif.

Meanwhile, back in Incline Village Bill got "into (resurrection of) a derelict casino (when APRs were like 24 percent) which went into Chapter 11, thereby cleverly forestalling the bank's efforts to foreclose." (You can't fire me; I quit!)

During the last, vast Sierra winter, Bill's garage roof decided to collapse one morning at 6 a.m., disaster being narrowly averted as he cut up the deck railing and, with the help of Shirley, was able to get her to tiptoe into the garage with a sledge wedge to raise the roof truss while he made an emergency run to the liquor store for some "much needed help." With the hopeful acceptance of Allstate, Bill and Shirley (based on their "valuable experience") "are going to build another residence to be used if the record-breaking snowfall of this winter is repeated later." Bill is also "looking into some very interesting carbon fiber composites for which he is retaining **Jim Chabot** (an early Ford retiree), to see what auto application there might be."

Bill assures me that if the rest of our 275-member class (I was No. 275) contributed to this column accordingly, we could have material enough to carry us into the 22nd century. And meanwhile classmates could "come out and relieve Shirley while she's holding up the garage roof so she could in turn, relieve herself." Bill adds, "I'll keep busy running to the liquor store for help. . . . See you all in '86, which in itself is funny."

Puhleeze come to the 40th, Bill, you and Jim and **Norm Sas** and **Jack Aitken** and **Stan Young**, and all those dear old roomies we still care about.—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Bob Connors has been appointed to the position of vice-president (corporate operations) of V. F. Corp. He is responsible for all manufacturing and engineering operations worldwide, including plants and distribution centers in the United States and the United Kingdom, Belgium, Manila, Hong Kong, South Africa, Greece, Spain, and Canada. . . . **Francis Schanne** is president of the Engineers Club of Trenton, N.J.

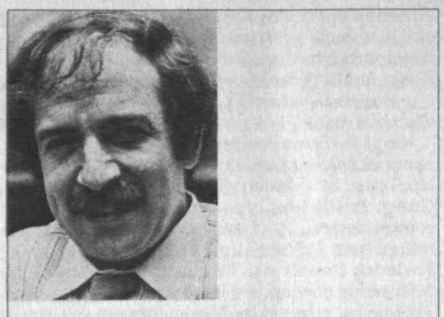
Virgil Pettigrew has retired as vice-president (finance and administration) of E-Systems, Inc., Dallas, Texas. . . . **Dudley Church** has retired from Crown Zellerbach Corp. as manager of process control services. . . . Last December, **John Sixsmith** retired from DuPont after 35 years there. . . . **Frederick Howell** says he quit the World Bank in 1980 and is playing tennis instead.

Some background on **Moshe (Moses) Arens**, Israel's defense minister: He came to the United States with his family from Lithuania after the outbreak of World War II. He finished high school in New York City, served in the U.S. Army, and went to M.I.T. After graduation, he went to Israel to join the underground headed by Menachem Begin. He finished a degree in aeronautical engineering at the California Institute of Technology and worked in the aircraft industry for a time before returning to Israel to stay. He was a member of Parliament for eight years and Israel's seventh ambassador to the U.S. He suggests that Prime Minister Begin chose him for the ambassadorial post because he speaks English. Some more serious comments (made in February): "People look on the Middle East as if it were the Middle West. What they don't realize is that our margin of error is so small. Our physical existence is at stake. . . . What Israel is to me is the insurance for the survival of the Jewish people, which is of supreme and ultimate importance, given the attempts to liquidate the Jewish people in my lifetime."—**Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

48

Bernie Gordon has endowed a fund to support undergraduate curriculum development in the M.I.T. School of Engineering and has provided operating funds to be used for the School's short-term curriculum and textbook development needs. "The endowment will ensure that the curricula reflect the principles of recent technology and are responsive to the needs of industry," said Gerald L. Wilson, dean of the School of Engineering. "Bernie has a long-standing history of concern for the quality of engineers in this country. His writings and his actions as an entrepreneur and as the engineering leader of a successful corporation testify to his personal interest and commitment to the education and nurturing of engineering leaders." These two gifts, totalling $2.2 million, are further demonstration of his deep concern for engineering education and his support of M.I.T. Earlier, his endowment of the Bernard Marshall Gordon Professorship of Engineering Innovation and Practice had the goal of stressing proficiency, creativity, and product development in the education of electrical engineers. Dean Wilson said, "Bernie has often differed with our perception of the proper emphases in educating engineers for leadership roles in industry. These gifts by no means assure that he agrees with everything we are doing, but they clearly demonstrate to me his commitment to this institution." Bernie is board chairman and technical director of Analogic Corp.

During a 13-day trip last June, **Bill Zimmerman** and several other American industrial leaders were given a V.I.P. tour of Russia. Bill was invited as a guest of the Russian government to give a talk on business conglomerates. Bill operates Zimmerman Holdings, Inc., in San Marino, Calif., a holding company that owns nine diverse companies, with products that include ducting and bellows for aircraft, ground support equipment for airlines, parcel delivery service, construction engineering for process industries, motorcycle helmets, life support and oxygen equipment for ambulances, plastic gym equipment, poles for pole vaulting, and oscillators. Before 1977 Bill was president of Monogram Industries. Bill remarried three years ago, and his new



Martin Klein, '62, president of Klein Associates of Salem, N.H., is New Hampshire's Small Business Person of the Year. Klein Associates has been a pioneer in the development of side scan sonar and sub-bottom profilers for ocean exploration.

wife has two daughters. . . . **Bob Mott** is as busy as ever. He is director of studies and secretary of the faculty at the Kent School in Connecticut. Bob told me during a recent phone call that he had reached the big six-oh: his sixtieth birthday. He said no surgical miracles have been performed on him—really, not even an interesting cold to report. The Reunion Committee had hoped that Bob could join us at our 35th Reunion and again be the master of cermonies during our Saturday evening program, but unfortunately, Bob wasn't able to be with us this year.

Bill Cummings sent a great collection of memorabilia for display at our 35th Reunion. He included his membership card in the Flat Foot Floogee Club. Bill recently had open-heart surgery and has retired from his responsibilities as plant manager of G.M.'s Saginaw Steering Gear Plant. . . . **George Brown** retired from American Motors in January. . . . **Ken Brock** has a new job as vice president of development for Polytechnic Institute of New York. Brooklyn is doing a major rejuvenation of the downtown area and this is being integrated into Polytechnic's new plans for an expansion program. Polytechnic already has a distinguished record in several areas of science and technology, including world recognition for its achievements in polymer chemistry. Ken and Ann's son, Charley, graduated from Haverford College in June.

Bob Bliss and Rose Marian Head Andrews were married this March in New London, N.H. Bob and Nan will live in Georges Mills, N.H. Nan was director of a handicrafts program in New Hampshire for the 10 years prior to their marriage. Bob and Nan recently drove to New Orleans, and they stopped in Montgomery, Ala., to visit Nan's mother. Bob is a director in the Office of Resource Development at M.I.T. . . . **Dave Cist** has retired from Du Pont. Dave and his wife, Mary, have a summer place on Cape Cod as well as a home in Newcastle, Del. Dave Cist and Bob Bliss were in the Army together and were the first two veterans to enter M.I.T. in July, 1945. Dave had started at Princeton, and Bob had started at Brown.

Graham Sterling has completed his five-year term as president of the Class of 1948. Graham successfully spearheaded several programs to increase class participation in financial support of M.I.T. He personally visited classmates in France, England, and in many other cities here and abroad. He hosted class mini-Reunions at Endicott House every Christmas since being elected as president. For our 35th Reunion he succeeded in arranging to have Professor Gyorgy Kepes create the painting "Open Horizon" for the occasion. (Reproductions of this painting, suitable for framing, are available for purchase by all classmates.) Graham proposed goals for our Class support of the 1983 Alumni Fund at a class meeting in 1978. The goals were: to increase participation from 44 percent of active members in 1978 to 60 percent in 1983; to increase average annual contribution per average participant from $71 in 1978 to $96 in 1983; and to exploit the relatively untapped potential of corporate matching contributions to amplify personal contributions. By 1982 our participation ratio had increased to 55 percent and our average annual personal contribution was $85. The results for 1983 will be announced soon, and we have an excellent chance of reaching the goals that Graham suggested. I believe that our class's emphasis on matching contributions encouraged the Alumni Association to make this one of their top priorities for all classes. The overall improvement is very large for the entire Alumni Fund in this category. Graham, with the help of Bob Freidman, '48, at G.E., saw a 2.5 times increase for our class in matching gifts from 1978 to 1982.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806, (401) 245-8963

49 35th Reunion

Albert Levingston joins the '49 Grandfathers Club with the birth of their grandson Michael Stevens Vener. . . . **Russell N. Cox** is trustee of Boston's Union Warren Savings Bank. . . . **Anatol W. Bigus** has written *Make Yours In Stocks and Bonds At Little Risk*. Andy outlines a security evaluation system and says his method reduces risk and the effects of the economic climate. Andy also recommends that each '49er read **Edward Thompson**'s "If You Want to Sell to the *Reader's Digest*" in February's edition of *The Writer*. Being editor-in-chief of the *Digest*, Ed ought to know.

It is sad to report the death of **Richard Kilburn**. . . . Ruby and **Len Newton**'s guided tour of China is now imminent—for this October jaunt quickly get in touch with the M.I.T. Quarter Century Club. . . . **Eric Howlett** has invented LEEP, a 3-D, stereo camera with no color fringing on the edge of the pictures taken with his wide-angle lens.

Our 35th Reunion starts Thursday, June 7, 1984 with cocktail party, class meeting and the Boston Pops. On Friday, there will be some local Boston activities, and then . . . then on to the Wychmere Harbor Club on Cape Cod, or the Inverurie Hotel on Bermuda . . . Which? At this typing time, I put a call in to **Harry Lambe**, but no decision at this time. Very soon we shall know.—**Paul E. Weamer**, Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017, (414) 576-9919

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"The Class of 1950 will host its annual dinner for Class of 1950 Scholars on Wednesday, October 5, at 6 p.m. in the M.I.T. Faculty Club. Members of the class in the Boston area, please save this date on your calendar. Others, who may be traveling to or near Cambridge in early October, please try to adjust your travel plans to join your classmates and the undergraduates now receiving the benefits of the Class of 1950 Scholarship Fund."—*Ed.* (**John T. McKenna, Jr.**, Secretary, One Emerson Pl., No. 11H, Boston, MA 02114)

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Myron Lecar reports that he is currently active with a colleague in Cambridge, England, developing a theory on the formation of the earth. . . . **Orlo A. Powell, Jr.** writes, "I am assistant dean for development in the School of Engineering at the University of Connecticut. Last May, I returned to Briggs Field to play in the alumni lacrosse game against my son Allen, who is now a junior in mechanical engineering. We won! My wife, Nancy, a physician with the state of Connecticut, and I have two other children: John, a freshman engineering student at the University of Connecticut, and Mary, a junior at Wethersfield (Conn.) High School who is interested in veterinary medicine.

Walter E. (Mike) Johnson reports he is working on steel applications at G.E., trying to keep their appliance business competitive. In his spare time he recently won silver cups in his golf league, bowled 614, and plays in two tennis leagues—attempting to stay young. He wonders about his baseball buddies from 1949-51 and asks to hear from you. . . . We regret to report the death of **Byron F. Burch, Jr.** on October 28, 1982.—**Gregor J. Gentleman**, Secretary, 818 Southwest Ninth St., Des Moines, IA 50309

54 30th Reunion

You may not be able to teach old dogs new tricks . . . but it's a different story with old M.I.T. grads. Three of our classmates have new jobs. **Robert Mackintosh** recently joined Teledyne Brown Engineering in Huntsville, Ala. . . . **David Myers** is now working for Wang Laboratories in Lowell, Mass. . . . **Valentino Grandis** retired as managing director and general manager of I.C.L. Italia International Computers. Val is now working as a consultant on renewable energy and is promoting an intermediate concentrating solar collector, which he has patented.

James Hyde must be doing something right. He has 20 patents and at last count had authored 110 scientific papers! Jim is professor of biophysics at the Medical College of Wisconsin. He is also director of the National Biomedical ESR Center, which is sponsored by the National Institute of Health. . . . **Bob Warshawer** has convened the first meeting of the 30th Reunion committee. Count on hearing from him in the not-too-distant future, but more important, count on attending the reunion on June 7-10, 1984.

Once more it is our sad duty to report the death of a classmate. **Charles E. Leonard**, who lived in Burlington, Vt., died on March 1, 1981. We extend our condolences to his family.—**William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

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Laurance Moss writes from Estes Park, Colo., to make a correction to the class notes in the April 1983 issue (pg. B15) regarding the appointment to the Energy Reserve Advisory Board (ERAB). The appointment was by the U.S. Secretary of Energy, to whom ERAB reports. There is no formal connection between ERAB and the Electric Power Reserve Institute (EPRI)—though Floyd Culler, the President of EPRI, is also a member of ERAB.

On a very sad note we receive news of the death in May of **Dick Teper** of a heart attack. In the December 1982 issue there was an extensive note from Dick on his activities. Dick and his wife Sandra made residence in Canoga Park, Calif., where Dick was responsible for program integration for propulsion systems at Rocketdyne, (division of Rockwell International). Our heartfelt condolences to Sandra and the three Teper children, Randy, Susan and Jay.

Via the grapevine we hear that **Jack Saloma**'s book on the conservation movement in America will be in print soon; we'll surely want to read it and will be watching for it. . . . **Robert B. Northrop** is professor of electrical engineering at the University of Connecticut, where he heads the graduate program in biomedical engineering. Robert has just developed a new E.E. undergraduate lab in microprocessor applications. The Northrops enjoy life in northeast Connecticut, fishing, hiking, and horseback riding. . . . **Charles H. Kruger, Jr.**, is chairman of Mechanical Engineering as of September 1, 1982. . . . **Bob Kaiser**, who just returned from a trip around the world, visited with **Gilbert J. Weil** in Paris.

By the time you read this, I (your western correspondent) will have visited my family in Venezuela, and should have some news from classmates there for our notes. As you can see, news is a bit scarce, so please drop us a note.—

Robert Kaiser, 12 Glengarry, Winchester, MA 01890, (617) 729-4345; Caroline D. Chihoski, 2116 Davies Ave., Littleton, CO 80120, (303) 794-5818

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John Collins writes that he is now a senior scientist at Hughes Aircraft Co. and is responsible for design of satellite high power amplifiers such as those used on the forthcoming direct broadcast satellite (DBS). John spent the month of April sailing in New Zealand's Bay of Islands. . . . **Henry J. Durivage** retired from the U.S. Air Force effective June 1982, after 25 years service and has returned to school at Louisiana State University in Shreveport, La. to pursue a master's degree in computer science.

Herbert F. Schwartz is a partner in the New York patent and trademark law firm of Fish and Neave. Recently Herb headed a team of litigators representing Polaroid in its five-year-old suit against Eastman Kodak over Kodak's introduction of an instant camera. Herb, his firm, and the case are discussed in the April 1983, issue of *The American Lawyer*. Herb lives in Riverside, Conn. and teaches patents, trademarks, and unfair competition as a lecturer in law at the University of Pennsylvania Law School.—**Vivian Warren**, Secretary, 156 Northrop Rd., Woodbridge, CT 06525

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The news is very sparse this issue, most of it from the newsclipping service. I received a report that **Steve Smith** is now a director of Ryan Homes, Inc., in addition to being executive vice-president, operations. . . . **Raymond Wenig** writes that he spent the last year developing a series of training programs on personal computers for managers, robotics, and information utilities. His family spends summers on Cape Cod in Cotuit and enjoys cruising the south New England coast in their sailboat. . . . **George Wyman** is now vice-president, finance and administration for Waters Associates, which is apparently a subsidiary of Lotus Development Corp. in Cambridge.

Finally, I have the sad duty to report the death of **Richard Daleas**, who was a 16-year employee of Combustion Engineering Inc. in Windsor, Conn. He was the manager of plant systems analysis and the recipient of the company's outstanding achievement award in nuclear power systems. He received his bachelor's degree in chemical engineering and his master's and engineer's degrees in nuclear engineering from M.I.T. and was a member of Phi Kappa Theta fraternity.—**John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

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Congratulations to Robin and **Terry May** who were married on March 27, 1983. Terry is vice-president of finance at Power Climber, Inc. . . . Congratulations also to the **Gervasio Prados** on the arrival of their son, Thomas, on October 7, 1982. The proud parents report that he is growing very fast and keeping them busy. Gervasio is a senior scientist with Bolt, Beranek, and Newman and lives in Cambridge. . . . **John Rible** sent an epistle from Porter Square, Cambridge, where he has been living since 1974 in a group-owned house. He has written some interesting software packages for the IBM personal computer and is very active in community projects in the Boston area. He visited with **Dan Allen** and **Jerry Abraham** and their families in LaJolla, Calif. in March 1983.

Thomas Hutzelman and his family visited New England in the summer (1982) and stopped off at the Institute. Their son Jeff is, according to his dad, a full-fledged computer nut and particularly enjoyed a tour of the data processing center. Tom has his own business, Flex-Y-Plan Industries, which manufactures office partitions and systems furniture. He enjoyed a record year in 1982, despite the soft U.S. economy. . . . **James Weigl** also runs his own business, Isothermal Systems, and reports business was up 50 percent last year.

Some news from the southern California contingent. **Rick Lucy** is now living in Hermosa Beach and working as a senior sales consultant with Caldwell Banker in industrial and investment real estate in Los Angeles. His son Sean is 6, and daughter Catherine is 3. . . . Living nearby in the Pasadena area but with a different lifestyle is **Tom McDonough**, who was voted one of the five most eligible bachelors in Pasadena by the women readers of the *Pasadena Star-News*. Tom was recently named a member of the International Astronomical Union's Commission on the Search for Extraterrestrials. An extra pat on the back for Tom for being one of our most regular contributors to class news.

Richard Millman is now head of the mathematics and computer science department at Michigan Tech. He is four hours north of Greenbay, Wis. He has co-authored three books and co-edited two. . . . Also leading a campus life is **Ken Browning**, who is the chief business officer at Illinois Wesleyan University, Bloomington. Ken is active with the Cub Scouts and youth soccer.

From out in the oil patch country we heard from **Jim Lanyk** who works for Drilling Mud, Inc. in Casper, Wyo. Jim asked the whereabouts of **Ken Howard** and would appreciate hearing from him. He attempted to visit Ken in Butte, Mon., but found he had moved on. . . . **Rex Ross** has been named executive vice-president of Geo Quest International, Inc., an oil and gas exploration consulting firm. He has taken up wade fishing in the surf and bays of the Texas coast and also enjoys quail hunting and tennis.

Bill Klepser is back in Port Alleghany, Pa. as senior equipment engineer for Pittsburg Corning Corp. He spent the last year on a special project in Missouri and is glad to be home again. Bill is now the proud owner of a 1947 Cessna 140 airplane and enjoys working on it as much as flying it. . . . **Bob Large** is now director of operations, development and services, for Arco Metals. Bob and Jane continue to travel extensively on business. Their son, William, is a fine basketball player with aspirations to attend the Air Force Academy. Their daughter, Mary Jane, is (to quote her father) "a real beauty" who enjoys camping with the family. Bob and Jane encourage visits by classmates going through O'Hare. They can be contacted at (312) 577-5513.

Joe Shaffery, assistant treasurer of The Allen Group, has been busy, as the company brought out a new issue of common stock in June in order to raise $20 million. The money is expected to be used for acquisitions which should keep things hopping for some time to come. The Shaffery family is very active in track. Daughter Helene (12), was the school district champion at 600 meters and in the long jump, and son Joseph was on the track team in high school. The kids have signed the old man up for a three-mile road race in town. That's all the news. Don't forget to write.—**Joseph Shaffery**, Secretary, 34 Hastings Dr., Ft. Salonga, NY 11768

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Mike Scott opened a law office in Manhattan Beach, Calif., specializing in computer law and patent, copyright, and trademark law. He is executive director of the Center for Computer/Law and publisher of the *Computer/Law Journal*, *The Scott Report*, and *Software Protection*. . . . **Alan Gevins**, of EEG Systems Laboratory in San Francisco, is continuing his research on higher cognitive functions of the human brain. His latest work is described in the April 1 issue of *Science*. He is considering the merit of VLSI networks modelled on the brain. . . . **Bill Ford** has been promoted to full professor of mathematics and computer science at the University of the Pacific, Stockton, Calif. . . . **John Rudy** has changed disciplines within Raytheon and now manages a large CAD/CAM software organization. He forwarded an article about **Richard Bryant** that appeared in the January/February 1983 issue of *VLSI Design* journal. The article reports that Ford Motor

Wanted: More Hands-On Risk-Takers for U.S. Enterprise

Three management practices of the last decade are responsible for much of the current trauma in U.S. basic industry, says **Michael E. Brose, '58,** president of the Technology Consulting Group, Boston:

☐ Promotion of "hands-off" instead of "hands-on" managers.
☐ Management by "portfolio analysis."
☐ Achieving business growth by acquisition instead of superior research and development.

Between 1960 and 1977 the proportion of chief executives in major industry having legal and accounting ("hands-off")—instead of technical ("hands-on")—backgrounds swelled from 15 to perhaps as high as 30 percent, Mr. Brose told the Boston Chapter of the North American Society for Corporate Planning late last year. But M.B.A.s and lawyers tend to be "dedicated to minimizing risk instead of maximizing opportunities," Mr. Brose noted. It's "like asking an arm-chair quarterback to call signals for an NFL team."

Portfolio analysis is another strategy for averting risk. "Instead of focusing on strategies to make each unit of a company more successful in its own industry," Brose told the corporate planners, "managers simply dispose of whatever isn't paying off and look for new acquisitions with profit records." Only later do managers discover that this strategy has neglected what Brose calls "the real guts of the business—the making of goods and development of new products and services."

The Gusts of Good Fortune

Getting funds for research can be tough. Too often, researchers are linked in the public's mind with fictional images of mad scientists. Or they are ridiculed by short-sighted politicians who complain that research projects produce no immediate, concrete results. Scientists frequently don't know who will support their research from one year to the next.

Then one evening a surprise phone call informs one researcher of a $179,900 windfall to do with as he pleases—no strings attached. The phone call that may be every scientist's dream became for **David L. Felten,** '69, a reality. The former Indiana University School of Medicine researcher is one of 20 recently selected MacArthur fellows. He couldn't apply for the grant; he didn't even know he was nominated. (Names are submitted by 100 anonymous nominators who seek candidates showing talent, originality, and self-direction.) Felton will receive $34,000 this year and $800 raises for the next four years from the John D. and Catherine T. MacArthur Foundation.

David L. Felten, '69, MacArthur prize winner, enters brain cell data into the computer. (Photo: John Starkey, *Indianapolis Star Magazine*)

Basic Research: A Step Ahead

The MacArthur award supports the potential of individuals in a variety of research and creative fields, rather than specific projects or specialties. The hope is that the recipients somehow, someday, will be able to make important contributions to civilization. Felten, a professor of Anatomy and neurobiology, says the grant is especially welcome in basic research, where both money and moral support tend to be in short supply.

Basic research is not something that can be described easily in cocktail party chit-chat, explains Felten, who researches at least four major areas in the neurosciences. But he provides the example of his mother who is paralyzed from polio. Without basic research, the only reaction to this plight might be development of a better iron lung. Instead, researchers found ways to prevent polio and to detect it more easily.

"This award gives me the freedom to pursue ideas that may not be as fundable from a safer perspective. It allows a person the chance to fail, to throw out an idea and go on to the next," Felten says. "A negative result is not necessarily bad. It can be good because it gives you a piece of information," he explains. "The MacArthur Foundation had incredible foresight in understanding the need to take calculated risks," he adds.

Plans for the Money

Felten hopes the award will enable him to accelerate his projects and to attract more good people to work in his laboratory. He believes one of the best things a researcher can do is to train someone who might be magnificent.

He is quick to share credit with his co-workers. His biggest contributions, Felten says, are drive, enthusiasm, and direction. Although he does good, solid research, he has never considered himself a cut above the many bright, competent researchers at Indiana University and around the country. The MacArthur prize is simply the latest in a series of fortuitous opportunities. A scholarship allowed him to attend M.I.T., and he received his medical and doctoral degrees at the University of Pennsylvania in a medical science training program that provided complete support. The MacArthur award was a positive, confidence-building factor in helping him obtain his new position as a tenured full professor at the University of Rochester, he claims.

Felten and his wife Suzanne, also a neuroscientist, collaborate on some research projects. Their rule not to bring work home lasted less than 24 hours, he says. They enjoy discussing research problems late into the night. One of the couple's "hobbies" is conducting seminars for therapists on rehabilitating patients with brain injuries.

Felten says his most exciting, provocative research concerns nerve fibers that innervate immune structures, such as the spleen, thymus, lymph nodes, and portions of the gastrointestinal tract. If the nervous system exerts direct control, it could be readily manipulated by chemical compounds to control immune responses. This also would explain why some depressed or bereaving patients have different immune responses to illness compared with other patients.

Another area Felten explores is catecholamine cells—brain cells associated with depression and psychiatric disorders. He is attempting to understand the chemical mechanisms of local control so that these cells can be manipulated to prevent adverse conditions.

He is also looking at the chemical regulation of the autonomic nervous system. How the brain controls muscle movements is fairly well understood, but how it controls the viscera—heart, lungs, and gut—is not as clear.

Felten's fourth area of research involves nerve problems related to diabetes. In animal models, Felten found autonomic changes that human diabetics experience. In collaborative work carried out in Professor Richard Peterson's lab at Indiana University, insulin-treated rats showed degeneration of somatic nerve fibers. This could be a direct result of insulin treatment or an indirect result of episodes of low blood sugar, they theorized.

He refers to basic research as "down in the trenches." It isn't chosen for fame and fortune. It isn't as financially rewarding as being a physician in private practice. It's a career the strongly curious choose for enjoyment, Felten says.

Felten also spends much time in the classroom instructing medical students. He enjoys eliciting groans for his incurable punsterism. An example? The sign on his laboratory door: "dis-astrocyte."—*Brenda Batten*

recently selected Richard as vice-president for development engineering at its new subsidiary, Ford Microelectronics, Inc. (FMI). As a result, Richard and his family have exchanged the hectic pace of Silicon Valley (where he was director of engineering at Synertek) for the calm of Colorado Springs and a home located in the woods. Richard's group at FMI is getting involved in user-designed VLSI and will set up a cell-library-based methodology, including a gate-array option. After M.I.T. Richard spent five years at IBM and three years at Cogar. . . . **Don Oestreicher**'s career has settled into computer-aided design, a field he enjoys because of its endless source of unsolvable interesting problems. After employment with Xerox in El Segundo and Versatec in Santa Clara, Don is now vice-president, engineering at Valid Logic Systems, Inc. in Sunnyvale, Calif. Valid is a technology leader in the CAE explosion and has been in business and doing well for about two years. Don celebrated his 11th wedding anniversary last spring and has two beautiful daughters, Jennifer, 2, and Megan, going on 1. At last report Don was planning to run in the San Francisco Marathon. . . . Your class secretary was recently promoted to vice-president, General Counsel at Ramtek Corp. in Santa Clara, Calif.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

69 15th Reunion

I have just returned from a trip to South America. Rio was very hot (even in January); the lake regions of Chile were interesting and pleasant; and San Carlos de Bariloche (Argentina) was likewise enjoyable. The 1,000 copies of the signed edition of Stephen King's book *Christine*, which I published, should be sold out soon.

Our 14th Reunion will be held on Saturday, August 6. Once again the **Sina Najarians** are making their summer house in Hull available for this activity. If you think you might be able to make it, please get in touch with Sina at (617) 925-1667.

Mike Laird spent a lot of time in Europe last year, working primarily in Helsinki and Leningrad. . . . After three years in England, **Alan Ratner** now lives with his English bride in Columbia, Md. . . . Kathy and **Gregory Aeder** are living with their four children—Kail, Sean, Glenn, and Katie—in Bedford, Mass. Gregory is a software manager at Raytheon and plays the fife with the Bedford Minutemen in his spare time. . . . After four years as production manager, **Michael Neschleba** is now new product and development manager for Polaroid's sheet manufacturing division. . . . **David Cane** has left Digital after eight years to become director of hardward engineering at MASSCOMP in Littleton, Mass. . . . **Robert Schaeffer** is the research director, Joint Committee on Human Services and Elderly Affairs of the Massachusetts State Legislature. He also does a lot of freelance writing, including co-authoring the campaign manual, *Running to Win*, and has recently adopted a 3-year-old Columbian boy.

Still working for Digital is **Steve Rothman** who claims to be trying to convince the rest of the Digital engineering community of the benefits of custom MOS VLSI designs. He's also become a Massachusetts politician, now serving on the local Bolton School Committee. . . . I received a notice from **Irene Greif** and Albert Meyer about the birth of their son, Eli Greif Meyer, last fall. Irene works at the M.I.T. Computation Center.

In January **Bruce Heflinger** moved from Boston to Burlingame, Calif. and commutes to Hewlett-Packard labs in Palo Alto where he's studying photoresistant materials for X-ray lithography. He is planning to fly back to Boston for the Phi Sig alumni party on November 12. . . . **Robert Harrington** is now a partner in the consulting department of the San Jose, Calif., office of Authur Young and Co., primarily consulting to start-up high technology companies. . . . Also in San Jose is **Stephen C. Poppe** who is manager of Management Sciences for Tymnet. Steve would like to hear from other Student House alumni. . . . Nancy and **David Lyon** recently moved to San Diego, where David has joined M/A-Com Linkabit as an engineering director. Their new daughter, Sara, was born last fall. . . . Finally, being run ragged by his 1-year-old daughter, Tammy, and tired of sliding down California hillsides, **Jim Taggart** is anxious to get back to the level East.

Joel Morgenstern is now in his second year as a family practice resident at Glen Cove Community Hospital, N.Y. He and Kathy now have a 1-year-old son, Kevin. . . . **Matt Franckiewitz** is still an attorney for the NLRB in Pittsburgh and recently sold a program and accompanying article to *99er*, a magazine for owners of the TI 99/4 computer.

Brazos Guido has started a new business venture by selling franchises in "The Yogurt Pump" (a frozen desert), and expects to open ten shops in San Antonio and Dallas in 1983. . . . **Talal Keheir** is "working like a beaver" trying to put his company, Oryx Systems, on the map as a national supplier of quality microcomputer hardware and software. . . . **Marc Davis** lists as his achievements (in this order) his new and first son, Jeremy, and his winning of the Newton Lacy Pierce prize of the American Astronomical Society.

Joseph S. Verducci reports that he is teaching statistics at Ohio State. . . . **Robert Carter Austen** is still with the Chattanooga Opera, as artistic director and conductor. Robert is also music director and conductor of the Cheyenne Symphony Orchestra and made his international debut in June leading the Symphony of Maracaib, Venezuela. . . . **David Kelleher** is still working for IBM at their Information Systems Office near Falls Church, Va., and reports that over the past three years he has enjoyed the Washington, D.C. area more and more and is missing the Boston winters less and less.

Larry and **Kim (Winters) Viehland** are still in St. Louis. Larry is now a full professor of chemistry at Parks College of St. Louis University, while Kim teaches at Chamnade and writes for both the bi-semester chemistry newsletter for the American Chemical Society and a weekly church newsletter. Also in St. Louis is **David Silverman** who is now in the engineering area in corrosion and materials technology at Monsanto. Although he is paid to worry about rust, David is now secretary/treasurer of the local M.I.T. Club and is busy with 1-year-old Roshelle Sarina and 4-year-old Ari.

Finally, I have a note from someone who is a senior vice-president at Atari and has two children, Jessica (3) and Taylor(2), but did not indicate just who they were. (The Alumni Office usually writes your name on the section of your contribution form for class notes but slipped up this time.)

This pretty much catches me up. Please remember that this is being written in May, so there is quite a delay from when you send in some information and when it finally appears. Please let me hear from you.—**Robert K. Wiener**, Box 27, M.I.T. Branch, Cambridge, MA 02139

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Timothy Gilmore is entering his third year of family practice residency in Seattle. He has developed a certain specialty involving occupational medicine and environmental health. Recently, the family made a return trip to Boston to visit various friends. . . . **Peter Bishop** recently became manager of Information Management Technology for the software company, Forethought, Inc. of Mountainview, Calif. He and his wife have two sons, Thomas and Stephen. . . . **Christopher Cross** is presently building an all-solar house in Pittsfield, Mass. . . . **Paul Burstein** writes that Dotty is a freelance editor, which allows her to divide her time between her profession and looking after their baby, Rachel. Due to the change in the family situation, he has decided to look for a bigger house, in addition to pursuing marketing and proposal work for the Department of Defense.

Robert A. Wilk and his wife, Marilyn, were expecting their first child in June. He works with Melon Bank in the trust and investment department and has recently been promoted to vice-president and director of investment research. . . . **David Sheldon** is living in Burlingame, Calif. He has recently completed his duties in sales for Triad Systems Corp. and has taken a position with their planning department in Sunnyvale. . . . Monsanto has announced that **David Silverman** of their corporate engineering department has been named an associate fellow to recognize his significant and continuing contributions to the company. He has been with Monsanto since 1975 as a senior research engineer and thereafter as an engineering specialist, where he now acts as a materials consultant and develops tools for corrosion prediction.—**Robert O. Vegeler**, Secretary, Dumas, Backs, Salin, & Vegeler, 2120 Ft. Wayne Natl. Bk. Bldg., Ft. Wayne, IN 46802

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Vincent J. Mannoia, Jr. read a paper on Whitehead's metaphysics at the Berkeley meeting of the American Philosophical Association and will be coordinating three workshops in Christianity and humanities this summer, funded by the National Endowment for the Humanities. . . . **Donald L. Estes, Jr.** and his wife, Susan, are expecting their first child in May. To keep themselves occupied while waiting, Susan is working on her dissertation and Donald is trying to bootstrap a software development company in the Boston area. . . . **Jonathan Y. Lukoff** is a partner, SCPMG, and is board certified (American Board of Pediatrics). He is enjoying the good life in southern California. . . . **Bharat Bhushan** received the 1983 George Norlin award, the highest honor the University of Colorado alumni association bestows on an alumnus. Dr. Bhushan received a B.E. honors degree in mechanical engineering from the Birla Institute of Technology and Science, an M.S. in mechanical engineering from M.I.T., a Ph.D. in mechanical engineering from the University of California, and an M.B.A. in management from Rensselaer. He is currently an advisory engineer in the General Products Division Laboratory of IBM. He holds many professional society memberships, has published over 50 technical papers, and holds several U.S. patents. He received the 1980 ASME Henry Hess Award for the best technical paper and the 1981 ASCE AIME ASME IEEE WSE Alfred Nobel Prize for outstanding technical papers. He lives in Tucson, Ariz., with his wife Sudha, son Ankur, and daughter Noopur.—**R. Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

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Paul Green and wife produced Sarah K. on November 30, 1981. Paul also managed to snare **Chris Tavares** into his company (Stratus). . . . **Elaine Kant** writes for the first time in ten years; she has earned a Ph.D. in computer science at Stanford, trekked in Nepal, taken karate, and become assistant professor of computer science at Carnegie-Mellon. . . . The noted bowler **Dennis Intravia** is product marketing manager for voice recognition and synthesis products at General Instrument Microelectronic Division in Hicksville, N.Y.

Paul Bailey received the M.S. from Berkeley; he is now an R&D project manager at Hewlett Packard. Wife Anne (Davis, Simmons University) and he have a 1-year-old, David. . . . **Ken Rosato** called and then wrote from Houston, where he is a title survey engineer for Amoco. Ken and frau have a new baby, Alyssa Marie, '04, as of January 31, 1983.

Ruth and I have sold our house and are building our estate, Chapel Hill, on 13 acres of Virginia's finest hill country. But till then, it's still. . . .—**Robert M. O. Sutton, Sr.**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

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Silke Schweidt reports, "Now that I am a medical student at the University of Cincinnati (Class of

Route 128: Europe's Highway to New Technology, Too

Let Europe take a lesson from Route 128 and Silicon Valley: develop "science parks" in which industries and universities work their magic to spawn new technology and new products.

Without such an initiative, says **Vittorio Baldini, '75,** of Montedison S.P.A., Milan, Italy Western Europe "as a cultural system, and thus as an independent economic entity, is eventually doomed in a global sense."

Speaking at a conference on Western Europe in the 1980s at Selwyn College, Cambridge, England, last summer, Mr. Baldini and two colleagues listed six requirements for entrepreneurial success in high technology: a highly competitive environment, ample venture capital, well financed research and development laboratories linked closely with a teaching university, a well educated workforce, an intellectual environment shaped by educational institutions and a commitment to specialization.

All these would be provided by Mr. Baldini's science park concept, he said—a university with good engineering and management training, a number of research laboratories, a central library and information processing service, and appropriate commercial and financial services. Such a park might occupy as much as 500 acres, Mr. Baldini said, and the initial investment would be as high as $100 million.

1986), I can appreciate what fun it was to live and work in Boston. Prior to my last job—a brief and happy career as quality control manager at Med Chem Products in Woburn—I was a research technician at Massachusetts General Hospital, which led to one article in print and another submitted. Here's to a residency on the East Coast!" . . . **Joe Sacco** is "preparing to leave for a five-month tour of Europe—next July heading for Albany, N.Y., for a two-year cardiology fellowship at Albany Medical Center."

Chris Cullen writes, "After graduating, I travelled, ski-bummed, and worked as a self-employed carpenter/cabinet-maker for four years. I spent two and a half years at Sprague Electric Co. in Sanford, Maine, as a process engineer, and am now back at M.I.T. pursuing a master's in mechanical engineering." . . . From **Rick McAdoo**: "Is there a coincidence in the fact that the Alumni Fund Telethon always calls me during tax preparation time? How do they expect me to be generous when Uncle Sam is supporting a family of four in Baltimore with my money? Nevertheless, I go on; the sun is shining, life is wonderful, and best of all, it's my day off. I expect to visit San Francisco again this summer, with hopes of somehow finding time, money, and inclination to add a trip to Amsterdam in the fall. Travel is wonderful." . . . I had a chance to chat with **Mike Sarfatti** just before these notes were due. Mike has switched jobs. He is now a project manager for RayChem. And he now lives atop Russian Hill in the heart of San Francisco. He sounds like a confirmed Californian now—the East Coast, in his eyes, has lost a great deal of desirability. The California habitat appears to agree totally with Mike, as with our other classmates out there.

While on a brief vacation, I had the pleasure of running into Dan Fylstra, '75, chairman of VisiCorp. I must say that computer people are almost as rushed as commmodity traders. Please do write, as my activities at Merrill Lynch Futures do not give much time to track news by phone.—**Arthur J. Carp**, Secretary, 15 Jones St., Apt. 3D, New York, NY 10014, (617) 741-3023

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David A. Gunter and his wife, Susan, are the proud parents of a son, Thomas David, born August 12, 1982. David is now with the law firm of Edwards & Angell, doing venture capital transactions, corporate and securities work, and law as applied to various areas of science and technology. . . . After completing his Ph.D. in mathematics at Berkeley, **Thomas D. Cochran** is now married, and has a position in the M.I.T. mathematics department. . . . **Richard W. Buck** was married last August to Jeanne Stokinger. Their honeymoon in Hawaii was followed by a return stop in San Francisco to visit friends from APO. Richard is still working in Kendall Square and living in Wilmington. . . . **Samuel Holtzman** is currently writing his Ph.D. dissertation at the Stanford Department of Engineering-Economic Systems. Samuel is also consulting with Strategic Decisions Group, a management consulting firm in Menlo Park. . . . **Sergio Cabrera** is now working on his Ph.D. in digital signal processing at Rice University in Houston.

Brian Backner sent a long letter describing his last six years: Brian spent two years at the Sidney Farber Cancer Institute, then went on to medical school at the University of Pittsburgh. He will return to Boston to start a residency at St. Elizabeth's Hospital this summer. Brian is getting married on May 28 to Regina Wiedenski, '78, in Garden City, N.Y. Regina has been in New York for the past four years, but will be starting a new job in Boston in July. Brian and Regina will be living near Cleveland Circle. . . . **Guy Nordenson** is working as senior engineer, specializing in earthquake engineering at Weidlinger Associates in New York City. . . . **Gary Porfert** is now married, with two children: Edwin, 2, and Andrew, 4 months. He is currently a U.S. Army captain, working as a chemist on safe destruction of various chemical materials at the Aberdeen, Md., proving ground. . . . **David Outzs** has a new home in Duluth, Ga. . . . **John Iori** has been working for the New York State Department of Transportation since 1977, and will be getting married to Debbie Alamowicz in June. . . . **Leo P. Harten** is pursuing his Ph.D. in theoretical plasma physics, and working summers at Hughes Aircraft in El Segundo, Calif.

Tom Gooch is working with Freese and Nichols in Fort Worth, "finding water for a thirsty world." Tom will spend some time in England this summer. . . . **Linda** and **Ron Pirek** have now settled in Windsor, Conn., where Ron is working in materials development for Combustion Engineering, and Linda is working as a programmer for the Connecticut National Bank. After leaving Washington, D.C., last summer, Ron and Linda toured England and Scotland, attending the Druid ceremony at Stonehenge on the summer solstice, before going to Connecticut. . . . **Chuck McGinn** finished his Ph.D. in physical ecology at U.C. Davis, and is now working with California Department of Conservation Windbreaks demonstration program, and continues to design homes. . . . **Steve Mel Aaronson** is working hard on computer-to-computer communications while enjoying the southern California sun.

Craig A. Johnston is now completing his post-doctoral work in neuroendocrinology at Texas Health Science Center in Dallas, and now has a daughter, born in July 1982, Hope Alicia Johnston. Craig has accepted a job at the National Institutes of Health in Research Triangle Park in North Carolina, starting next year.

Kathy Roggenkamp transferred to the University of North Carolina after two years with our class, but still keeps up with us. Kathy received her B.A. in anthropology in 1977. She has been working as a statistical programmer at the Lipids Research Project of the Department of Biostatistics at U.N.C.-Chapel Hill, but is now going back to school at U.N.C. for an M.A. in teaching. . . . **Thomas L. Mays** is currently manager for terminal development engineering at MCI Telecomm. Corp., in Washington, D.C. . . . **Stavros Macrakis** is currently a graduate student at Harvard. . . . **Alan D. Siggia** has started his own company, Sigmet, Inc., concerned with signal processing systems, in Acton, Mass. Alan will receive his S.M. degree this spring in Electrical Engineering and Computer Science from M.I.T. Alan and his wife, Ginny, are expecting their first child around Thanksgiving. . . . As for myself, I am preparing to spend lots of time spectating at the National Sports Festival this summer, and generally enjoying Colorado—**Barbara Wilson Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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Let's start with **Milton Roye**, who graduates from the Harvard Business School the day before our five-year reunion. After that, Milt is going traveling over the southwest before returning to work for General Motors in August or September. . . . Another recent graduate, **Debbie Kaden**, got her Ph.D. in Toxicology from the 'Tute this January. She's now back in her home town of New York doing post-doctoral research on ultraviolet light-induced mutagenesis at Columbia. . . . **Tim Reckart**, also gets a doctorate in June—his Juris Doctor from Stanford, as well as his M.B.A. Tim will then change coasts to work for Fulbright and Jaworski as a corporate tax attorney in Washington, D.C. Tim announces that he will be getting married next year to Jane Padwick, who just graduated from Stanford in engineering.

Now for some non-graduates. **Harold Kamens** writes, "After punting my Ph.D. work in Minnesota, I've settled near San Francisco, working for Chevron. Got married six months ago (to Peggy Broshat). Life in the land of the mellow is nice, but two weeks' vacation is barbaric! Chevron needs an I.A.P." . . . **Gary Brennan** hasn't punted his Ph.D. yet; he's still in graduate school at Harvard in biochemistry and molecular biology. He writes, "I'm trying to isolate sponge collagen genes. I am

getting married August 7 to Linda Dinckney, whom I met at Tech Squares, and who also was a graduate student at Harvard and is now working for Corning Glass."

Bob Russ writes to update us on his doings: After working in the fusion energy effort at Lawrence Livermore Labs and telecommunications product development at Roychem Corp. for several years, he returned to graduate school. He has just received an M.B.A. from Stanford and, with his own and other people's funds, is actively looking for partners and ideas for high-tech start-ups and new businesses in San Francisco, L.A., or Boston. I think we have a match for him right here in our own column. **Peter Santeusanio** is looking for the same thing. He writes, "Anyone interested in discussing potential new ventures or who is in the process of formulating or financing a new company that would like to get together to chat individually or as a group, please give me a ring." Peter's number is (617) 596-0490; Bob's is (415) 853-1029.

I have news from two California architects. **Rich Perlstein** writes that he is "still with the architectural firm of Kaplan, McLaughlin and Diaz, and I finally have a drawing table with a view of the Bay Bridge, the bay and (no snickers!) downtown Oakland. Tested the Sierra slopes a few times, skied unbroken powder—lousy form, but had a great time. Looking forward to the end of the monsoon season—gimme that fog!" Rich is in the process of completing his requirements towards becoming a licensed architect in the state of California. But **Ruth Shragowitz** beat him to the punch. Ruth is also in the S.F. area, and just this spring received her official license to create her own works of architectural wonder.

Neal Rockowitz, our tennis pro physician, writes that he is about to start his second year as a resident in surgery at the Harbor-U.C.L.A. Medical Center. He is planning on an orthopedics residency, while approaching the beginning of his second "blissful" year of marriage. Unfortunately, between his residency and his new bride, he has not had much time to enjoy sunny southern California. . . . Another happy marriage reported by **Phil Bugnacki**, who is "enjoying life tremendously" with his wife Kendall and soon-to-be one-year-old daughter Julia. Phil is still with Martin Marietta in Orlando, and got his M.S.E.E. from Florida Institute of Technology in May. . . . **Graham Copeland** writes to announce his new position with TRICAD, a new CAD company in Silicon Valley specializing in systems for the construction and office facilities markets. Graham is the product manager for facilities management, with responsibilities for product development and marketing. . . . Up in the wet Pacific Northwest is **Shannon Maher**, currently working as a seismologist for Sierra Geophysics while attempting to finish his dissertation in his rare spare time. "I'm also trying to stay out of Seattle's rain (unsuccessfully)."

Arty Lewbel, of juggling and unicycle fame, is almost done with his Ph.D. in economics from M.I.T. His dissertation should be done by December. . . . **Carol Boemer** is in the Bay area working as a consultant in business graphics and commercial graphic design. . . . **Kathy Rozanski** is a resident in New York Hospital and is getting married in September to medical school classmate Rich Isenberg. . . . Another marriage: **Regina "Queenie" Wiedenski** got married the weekend before our reunion to Brian Backner, '77. Reunion is planned as part of their honeymoon.

Elaine Harris is at Du Pont in Kingston, N.C. doing research and development in textile fibers and polyesters. . . . **Mark Picciotto** has two years of mostly clinical work to go on his Ph.D. from Michigan State University in Psychology. . . . **Gerard Kriss** is an assistant professor at the University of Michigan in Astronomy. Every two or three weeks he travels to Kitts Peak in Arizona to do observations. . . . **Mike Ferrell** is working on his J.D. at Fordham Law School in New York. . . . **Tom Janson**, J.D., is working for the prestigious Wall Street firm of Reid and Priest after law school in Miami, Fla. Tom and his wife Abbey have been married for two and a half years.

Another June wedding: **Bob Gels**, who is working on solid state electronics for microwave communications at Bell Labs in New Jersey, married optometrist Maureen Hanley on the first day of June. . . . **Sandi Haber Sweeney**, married for three years to Wharton classmate Bob Sweeney, reports that life in the suburbs of New Jersey is—well, reports that she is living in the suburbs of New Jersey. . . . **Gary Kurzban** wrote to tell us that he is still a graduate student at University of Texas in the Biochemistry department.

This column marks the final column in my first five-year term as your class secretary. I've enjoyed receiving, reporting and making up the news over the past five years, and I hope you all have enjoyed it as much as I have. Of course, I am running for re-election, so I might even continue as your secretary until our next reunion in 1988.—**David Browne**, Secretary, 50 Follen St., #104, Cambridge, MA 02138, (617) 491-5313, (617) 727-1190

79 5th Reunion

Hello, classmates. Can you believe that the next class reunion is *ours*? Boy, are we getting old! Enough getting maudlin—on to the news.

As of May 17, **Susan Ann Silverstein** is a lawyer, with a J.D. from Columbia. She plans to begin work in August with Southern Tier Legal Services in Bath, N.Y. She writes, "My work will involve welfare, health, and housing law, and because my position is funded through a community law fellowship program, I will spend 25 percent of my time doing community-oriented legal work. I couldn't be happier. My commitment is only for one year, so if I can't hack it out there with the sheep and cows, I'm free to come back to New York City. Meanwhile, I'll be doing exactly the kind of legal work I love most." Good luck to you, Susan. (Her new address is Southern Tier Legal Services, 56 Liberty St., Bath, NY 14810.)

Laura Rees and **Robert Willett** got married the end of May, the day before they both graduated from the University of California (San Francisco) Medical School. After that auspicious weekend, Laura and Bob planned to head back to Boston, where Laura will start an internal medicine residence at Beth Israel Hospital and Bob will start graduate physics work at M.I.T. (*Some* people never get enough of school!). Laura also provided dirt on the following people. **Jim Liebmann** also graduated from UCSF, after which he moved to Seattle to start an internal medicine residency at the University of Washington. **Bill Wraith** got his M.B.A. from Stanford this year, married Ellen Jacob from Stanford, and started a full-time job with Hewlett-Packard. Congrats to all.

Bennett Baker, my spies report, works for New England Research Labs. . . . **Rick Halvorsen** is an attorney practicing in Seattle (practice makes perfect!). . . . **Colin Maynard** is designing buildings for Pei, Johnson, and Yamasaki and teaching cross-country skiing for American Youth Hostels. . . . **Greg George**, at press time, was finishing his M.D./Ph.D. at Duke University. . . . Greg's Deke brother **Jim Lester** got his law degree from Duke in 1982 and is now with the Washington D.C. and McLean, Va., law firm of Watt, Tieder, Killian, and Hoffar, specializing in construction litigation and government contracts. Writes Jim, "Keeping busy with clients in the U.S., Canada, Mexico, and Europe, trying to computerize the firm's accounting and litigation support, and writing a chapter for an upcoming book on construction litigation." Sounds pretty busy to me.

Michael Fischbein just completed two years on board *U.S.S. Carl Vinson* as interior communications officer, during which time he qualified for "engineer on a nuclear ship." He is now reporting to the *U.S.S. Virginia*, a nuclear-powered guided missile cruiser, after attending Navy Electronic Warfare School. . . . **Dennis Toft** graduated from Columbia Law School in May 1982, and in June of that year, married Maria Campos (Tufts, '79). Dennis is now an associate with the law firm of Wolff and Samson in Roseland, N.J. . . . **Janet Metsa**, at press time, was planning a May 14 wedding with Michael Mullins, '80, in Geneva, N.Y. Mike completed his Ph.D. at the University of Rochester in May of this year.

Bruce Nawrocki is at Duke University getting a double master's in computer science and business (great combo, Bruce—that's what I have). His research is on possible data base systems on the IBM personal computer. . . . **Eran Brosky** is back in Boston attending Harvard Business School. . . . **Dave Westenberg** graduated Harvard Law School in June and accepted an associate position in the corporate department of Hale and Dorr in Boston. He reports, "Nancy and I love married life!" . . . **Bennett Golub** is in his fourth year of graduate work in applied economics at the Sloan School. He plans to finish up his Ph.D. in January. . . . Also at the 'Tute is **Robert Ulichney**, who will be starting graduate work in Course VI in September.

Pamela Berry will be getting a law degree and a master's on public policy from the University of Connecticut in May 1984. In August of this year, she plans to be married to James M. Chamberlain, a medical student at the University of Connecticut Health Center. . . . **Timothy Kraft** is currently working on his Ph.D. in physiology at the University of Minnesota. "This summer," he writes, "while not experimenting on the Walleye, our state fish, I will be making wedding plans with **Michelle Robbin**, who is currently working on an M.D. at the Mayo Clinic in Rochester, Minn. She finished her master's in mechanical engineering at the University of Minnesota in 1981. **Mark Hughes**, my old roommate, will be flying out from Berkeley to serve as best man." . . . **Richard Berry** is currently working on the design of an automotive CRT system with satellite navigation for the Ford Motor Co. The system can pinpoint the car's location within 1,200 feet anywhere on the earth! . . . **David Liu** is a first-year master's student at the Sloan School and was awarded a fellowship from the Bendix Corp.

In addition to the three M.I.T. marriages already reported in this column (that is, marriages of M.I.T. alums to each other), on May 28 I attended the nuptials of my good friend Regina Wiedenski, '78, to Brian Backner, '77. Also attending were **Ken Keverian**, Dorota Klepacz Keverian, '78, Nancy Lukitsh, '78, and Susan Morgello, '78. Rather than wedding bells breaking up that old gang of mine, weddings provide a great opportunity for us all to get together!

Are there any New York area alums out there who are theatre fanatics like moi? If so, drop me a line and maybe we can pick up half-price tickets one of these dull summer nights! Hasta la vista.—**Sharon Lowenheim**, Secretary, 131 East 83 St., Apt. 2G, New York, NY 10028

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My old next-door neighbor, **Craig Goldman**, married Marsha Holzman (Simmons, '80) on May 22. Craig and Marsha had been seeing each other since our freshman year at the 'Tute. They are now living in Natick, Mass. . . . A note from **Michael Waxer** indicates that he is now working with video games in Los Angeles. (I don't know if that means he plays them or creates them!) Mike has recently become engaged to Debora Luehrs, '77, who is helping to clean up toxic wastes at China Lake Naval Weapons Center. Mike also reports having seen **Kenneth Oya**, while Ken was on leave from Fort Riley, Kan.

Keith Thompson, after spending three years working with an aviation/management consulting firm in "the doldrums of Westchester County, N.Y.," is now eager to "sample the rare delicacies for which southern California is so noted." Hmm, I think that I must have read a different guide book, Keith! At any rate, Keith has enrolled in the fall 1983 M.B.A. program at UCLA. . . . **Barbara Locke** is in Rogers, Conn., working for Rogers Corp. (Sounds like a company town to me!) Barbara just bought herself a house on a lake near work. Good luck with the new purchase, Barbara! . . . **Sheila Koneke** is working for IBM's Manufacturing Engineering in Manassas, Va. Sheila is getting mar-

ried in the spring/summer of 1984 to Bob Lease, orginally from Cumberland, Md.

Tomas Gonzalez is workinng in Puerto Rico on the completion of his S.M. thesis on "Remanufacturing Technology." (Wasn't technology manufactured right the first time?) He has started a company called Transportation Technology Caribe, Inc. The company will be doing management and scientific consulting, and will be setting up a vehicle and equipment remanufacturing facility in Puerto Rico. Their intended market is the Caribbean region and Latin America. . . . **Leonard Sax** is finishing up his third year in a combined M.D./Ph.D. program at the University of Pennsylvania. The Ph.D. is in psychology. . . . **Keith Therrien** is working as a management trainee for Weyerhauser Co. (Forest Products Co.) in Everett, Wash.

Brian Picht has been working as a design engineer for the past three years for Hewlett-Packard in Boise, Ida. Since "graduation" from the M.I.T. Symphony Orchestra, Brian has continued to be active with music and now plays violin in the Boise Philharmonic Orchestra and with a string trio called the Bak Trio. By the time this is printed, he will have married Karan Justus (on June 25). Karan recently completed her M.B.A. and is employed as an accountant with Hewlett-Packard. Brian and Karan recently purchased a new, geothermally-heated home. Brian reports that the annual heating bill is $240! I'm jealous!

Marian (Stein) Nodine and her husband Mark are in the process of buying a house in Waltham, Mass. Marian works for Bolt, Beranek, and Newman, Inc. in Cambridge. . . . **Louis Nagode** and his wife Jenny live in Colorado Springs and are the proud parents of a new baby girl, Melanie.

As for me, I'm currently getting ready to move. By the time you read this, I will be firmly entrenched in Stuttgart, Germany for (at least) one year. Bolt, Beranek, and Newman, Inc. (actually BBN Computer Corp., due to some recent reallignments in the company) are sending me overseas to administer and provide technical software expertise for a computer network. Oh, how I suffer for my work! For all of you classmates fearing that I will now be difficult to reach have no fear! An APO box in New York will provide quick and efficient service for all of your letters, postcards, announcements, and even garbage mail. So send one, send all! The new address is—**Kenneth A. Turkewitz**, Box 67, APO, NY 09131

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I'm sure everyone thinks they can't write to the class secretary unless they have some stellar corporate accomplishment to report. Ha! **Jim Askey** writes: "I'm still unemployed. Can't even get a job at the local McDonald's because I'm over qualified. The welfare will run out soon, and then I don't know what I'm going to do." Jim should take heed from **Donald Jones**. Don writes: "It's a great day to be alive! I use that as my motto when things get rocky. I'm beginning to like Louisiana weather—it sure makes running year-round easier. Ft. Polk is more likeable, too. I'm directing a charity for crippled children, publicizing Volksmarching, and finally meeting some of the people in my building. I may be deployed to support the peace keeping force in the Sinai. I'm excited about that adventure."

Enough of adventures in the Sinai and unemployment, let's move on to the more prosaic accomplishers. **Hans Von Spakovsky** writes: "I am attending law school in Nashville at Vanderbilt University; worked for a law firm in Boston last summer; will probably be back there again this summer. Miss the diverse, intelligent people of M.I.T., but *not* the problems sets." . . . Also, beginning a career in jurisprudence, **Polly Grunfeld** writes that she has been accepted to Stanford University Law School for September 1983. She is presently working for Exxon and plans to get married in December 1983.

John Lupien writes: "I am working for the computer services division at Charles T. Main. During a recent vacation, I saw **Michael Rosenthal** and **John Castelanno**, who are working for Hughes in Los Angeles. **John Bowden** is working for a laser company in Mt. View, living in Palo Alto. He's trying to spend most of his free time in the Sierras, mostly cross-country skiing. He's also trying to keep in shape on the side—raced in the ski-run-bike triathon at Squaw Valley recently. . . . **Louisa Ho** is director of planning for the Greater Richmond Transit Co. . . . **Walt Crosby** is information systems director for City of Boston Office of Property Equalization, developing a computer system for automated valuation of property for tax purposes.

But, Chuck, you say, is that all? Yes, and there'll only be more if you write. Take care all.—**Chuck Markham**, Secretary, 362 Commonwealth Ave., Apt. 2E, Boston, MA 02115

82

Chong Hoon Lee writes to us from Brown Medical School, where he and **Mark Dulong** have been chopping up cadavers. Chong Hoon says it's just not the same without the Student Center library, the coffee house and the game room. He's been wondering why he wasn't one of those who got a job in California, claiming that your salary is directly proportional to your distance from the 'Tute and the amount of work one gets is inversely proportional to that distance. (P.S.: For the inside story on **Rich Epstein**, or the answer to the question, "Why isn't Rich Epstein at Brown Med?" please write to classmate **Steve Taylor**.)

Mark Hartney received his master's in Chemical Engineering last February and is now working for Bell Laboratories at Murray Hill, N.J. . . . A couple of '82ers are in Ballston Spa, N.Y. at the Naval Nuclear Site. **Gerard Weatherby** and **Alan Hollenbeck** are both there, doing whatever one does at those kinds of places. . . . **Bryan Fortson** writes to let us know that he's working part-time on a master's in Engineering Management at the University of Dayton and that he's an Engineering Officer in the U.S.A.F. the rest of the time. . . . **John Hollis** has been giving me lessons on ornithology from his nest at San Antonio Zoo. John has been working with a white pelican, gaining its trust so that it will take food from John without "taking his fingers off."

Mark Szarawarski sends news of classmate **Gary Henderson**. Mark says, "Someone should break the news gently to the women of Boston that Gary's engaged." Gary's working for Lockheed in California, and says that the tight security requirements prevent even him from knowing what he's doing. Meanwhile, Mark's with Westinghouse. His first assignment in Orlando was super. ("Epcot Center was neat.") He then spent three months in Pensacola, Fla., and is now working for the Technology Interface Department of the Elevator Co. in Randolph, N.J. Mark visited Don Johnston, '81, in Tampa. Don's now off to begin a new job on the other coast at the Space Center.

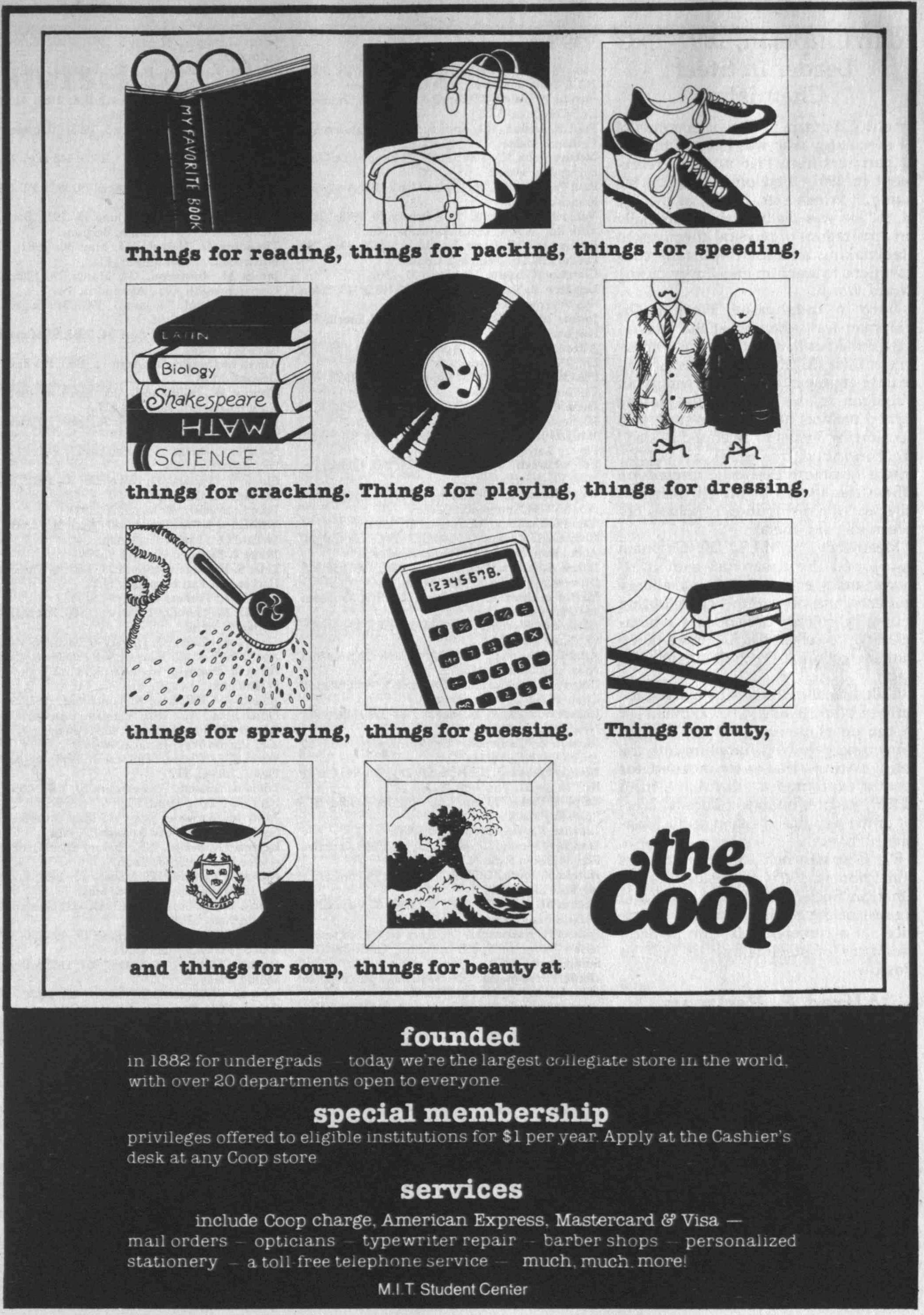
Steven Williams is attending Carnegie-Mellon University in Pittsburgh, Pa. He's in the Graduate School of Industrial Administration and will receive his M.S. in May, 1984. . . . **David Sheppard** is doing computer graphics for Applicon in Burlington, and starting a company called Sound and Visions for Audio/Visual Endeavors. . . . **Joe Kesselman** is an associate engineer/developer at IBM. He's designing logic for a high power processor. Joe will be moving to Kingston, N.Y., in a few months. He says he still hasn't found a wargaming group he likes, and he misses the "pure joy of Institute hacking." But Joe says rock climbing at the Gunks comes close. (What are the Gunks?) . . . **Evan Tick** is currently a Ph.D. candidate at Stanford's Computer Systems Laboratory; **Eric Delkers** is at Berkeley, and he and Evan are attempting to sleep in every Mills College dorm before summer. . . . Congratulations to **Stephen Morgan**, who has been married two years now to the former Linda Kujan. Stephen's working at the IBM T.J. Watson Research Center on a compiler/database system for a high-level office automation system called O.B.E.—Office-By-Example.

Mark Huntzinger is working for Codex Corp. on a new generation of modem products. He says he's not swimming anymore but has started refereeing some New England water polo games. . . . **Shirley Koppel** is currently working at General Dynamics Fort Worth Division as a flight test engineer on the F-16 program. . . . **Richard Freeman**'s in the Ph.D. program at Cornell University. . . . **Stephen Bart** was working on antenna design at Martin Marietta in Denver. In September he'll be back at M.I.T. for E.E. graduate studies. . . . **Gerhard Straub** is working at E-Systems Melpar Division in Fairfax, Va. As well, Gerhaud's engaged to Jeanne Swecker, '83. Congratulations to you both! . . . **Grace Malloy** is an actuarial manager at John Hancock. Grace says, "I see law school on the horizon . . . maybe." . . . **Eddie Torres** wrote a while back. Eddie says that **Danny "Duck" Solomon** is now gainfully employed at an insurance firm in the Big Apple. . . . **Laurie Blake** expects to get her master's any day now. . . . **Dennis Lamser** is designing clinical instrumentation for Beckman Instruments, just outside L.A.

Arno Bommer sends news of '82ers and '81ers. Arno's an acoustical consultant for Hoover Keith & Bruce, Inc., in Houston. In his spare time he's been camping with **Mike Colucci** (who's in graduate school at the University of Texas in Austin), and Bill Flarsheim, '81 (who's working for M.W. Kellogg in Houston). Arno says that he and Bernie Deitrich, '81 (also at M.W. Kellogg), ran their first marathon, the Houston-Tenneco, in under three hours. Bernie beat Arno by several minutes. . . . **David Detlefs** is "hacking FORTRAN (ugh!) in a fairly non-violent portion of TRW." . . . **David Giramma** says he is currently working as an engineer with IBM, concerning testing of VLSI products. . . . **Lori Alperin** started grad school in computer science at the University of Pennsylvania last September, is now at IBM's T.J. Watson Research Center, and will return to school in the fall. . . . **Howard Lazar** was laid off at Lummus in New Jersey. Howard bummed around for a couple of months but is now back at work for Combustion Engineering in Windsor, Conn. . . . **Robert Zalucki** says he is finally past the first year of law school at Stanford. He is with Bingham, Dana, and Gould in Boston this summer. . . . **Don Habib** is working as a nuclear engineer for NUS Corp. in Gaithersburg, Md. He spent two months on a field assignment at San Onofre Nuclear Generating Station on the Southern California coast. . . . **Mindy Garber** is at Stanford getting her masters in Mechanical Engineering. She says she loves the weather but is tired of being in school.

Brad Suggs writes that he is a 2nd lieutenant in the U.S.A.F. working at the Rome Air Development Center in Rome, N.Y. as a research physicist doing therminic emission studies. He also has been nominated to the M.I.T. Educational Council. Brad visited Boston in July to take a summer session seminar in laser optics. . . . From *Tech Talk* I learned that **Andrew Bernoff** won a Marshall Scholarship. He's studying applied mathematics and fluid dynamics at Cambridge University's Trinity College. . . . The Cape Cod *Times* carried an article about **Glen Parker**. Glen spent last summer motorcycling from Europe to Gabon, Africa. It sounds like it was a pretty exciting trip. Glen spent time in Lebanon and Israel right around the time of the massacre of Palestinians by Phalangist soldiers. . . . **Doug Rohall** writes that he and **Chris Johannesen** have started their own consulting firm. They're "technilegal specialists," according to their letterhead. Doug's been spending time working on various communications projects, including a radio station in California and a mobile telephone service in Louisiana. Otherwise, he's "just going to law school" (at Yale).

Your secretary has been elected to the M.I.T. Corporation. So now, in addition to class news, I'd love to hear your every thought on M.I.T.—what's good, bad, indifferent. (Actually, I've always been interested in those kinds of thoughts—now it's just a little more official.) Unfortunately, my rock and roll band has flopped.—**Rhonda Peck**, 38 Bigelow St., Cambridge, MA 02139


MY FAVORITE BOOK
Things for reading, things for packing, things for speeding,
LATIN
Biology
Shakespeare
MATH
SCIENCE
things for cracking. Things for playing, things for dressing,
12345678.
things for spraying, things for guessing. Things for duty,
and things for soup, things for beauty at
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M.I.T. Student Center

John Chipman, 1897-1983
Leader in Steel Chemistry

John Chipman, professor emeritus of metallurgy who was head of the department from 1946 until his retirement in 1962, died on May 14 at his home in Winchester, Mass., at the age of 86. He was distinguished especially for applications of physical chemistry to steelmaking and for important contributions to uranium metallurgy during World War II.

Born in Tallahassee, Florida, Dr. Chipman was educated at the University of the South and the State University of Iowa (M.S. 1922). It was as a research engineer at the University of Michigan in the early 1930s that he gained national attention for studies in deoxidizing agents to be added to steel. He continued this work at M.I.T., where he came in 1937, with research on other basic factors in the chemistry of steel and the distribution of solutes between slag and metal.

Meanwhile, at M.I.T. Dr. Chipman developed the first course in thermodynamics ever given to metallurgy students, and despite the rigors of that course he quickly developed a reputation as an excellent teacher and a quiet, humane colleague to the students and staff.

Called to the University of Chicago early in World War II, Dr. Chipman led in the development of a method for converting powdered uranium into the solid castings that were needed for atomic experiments. On leave from M.I.T., he later became associate director of the technical division of the Manhattan Project.

Dr. Chipman held countless professional honors. He was president of the American Society for Metals in 1952 and a guest of the Soviet Academy of Sciences at a conference on the physical chemistry of steelmaking in 1957 in Moscow.

Alfred E. Perlman, 1903-1983

Alfred E. Perlman, '23, who had been president of the New York Central Railroad and later of the Western Pacific, died in San Francisco on April 30; he was 80.

Mr. Perlman was elected to the M.I.T. Corporation for a five-year term in 1965, while he was president of the New York Central. He opposed that railroad's merger into the Penn Central Transportation Co. in 1968 and two years later moved to the ailing Western Pacific, which he quickly turned into a profitable enterprise.

Deceased

Mrs. Harold A. Everett, '02; November 28, 1981; 262 E. Hamilton Ave., State College, Penn.
Harold W. Paine, '09; April 3, 1983; 246 Shoreline Dr., Columbia, S.C.
Fred R. Lufkin, '10; April 6, 1983; 24 Linden St., Portland, Maine.
Nelson Stone, '15; May 3, 1982; 74 Rendezvous Ln., Barnstable, Mass.
Paul Page Austin, '16; 1980; 49 Park Hilll Ave., San Francisco, Calif.
Valcoulon L. Ellicott, '16; February 10, 1983; 13801 York Rd., Apt. C-16, Cockeysville, Md.
Eugene W.V.C. Lucas, Jr., '16; April 26, 1983; 200 Leeder Hill Dr., Hamden, Conn.
Clarence K. Seely, '17; March 31, 1982.
Leighton B. Smith, '19; April 16, 1983; 143 Colon St., Beverly, Mass.
Joshua Muss, '20; April 17, 1983; 4-16 Fourth St., Fair Lawn, N.J.
Alfred B. Wason, '20; April 17, 1983; 94 Carriage Ln., PO Box 106, Barnstable, Mass.
Frederic J. Grant, '21; September 28, 1982; 609 Pleasant St., Ojai, Calif.
Donald H. Hatheway, '21; April 11, 1983; C/O R.B. Hatheway, 3 Seneca Ave., Geneseo, N.Y.
William J. Malone, '21; March 14, 1983; 561 Forest Pkwy., Largo, Fla.
Lee J. Purnell, '21; April 28, 1983; 1901 Quincy St. NW, Washington, D.C.
Lloyd Harrison, '22; May 5, 1983; 3001 Veazey Terrace NW, Washington, D.C.
Carl W. Shattuck, '22; August 17, 1981.
Charles H. Taylor, '22; April 7, 1983; c/o Cargill, Abbot Run Valley Rd., Cumberland, R.I.
Elliott A. Adams, '23; December 18, 1981; 5818 E University Blvd. Apt. 140, Dallas, Tex.
Martin H. Burckes, '23; April 10, 1983; Krontona 10, Ojai, Calif.
Edward McSweeney, '23; April 16, 1983; 200 E. 66th St., New York, N.Y.
Alfred E. Perlman, '23; April 30, 1983; 3205 Ralston Ave., Hillsborough, Calif.
Robert B. Davidson, '24; February 5, 1983; Merion Cricket Club, Haverford, Penn.
Robert W. Stewart, '24; May 7, 1983; 133 Hilltop Pl., New London, N.H.
Richard L. Gatewood, '25; February 14, 1983; 83 Avery Dr. NE, Atlanta, Ga.
Beverly Hubbard, '25; February 28, 1983; 245 Carter Rd., Route 11, Princeton, N.J.
Ralph F. Blake, '26; April 15, 1983; 180 Bradley St., Portland, Maine.
Leonard Kaplan, '26; May 12, 1983.
Francis F. Mevay, '27, March 12, 1983; 390 Andrews Rd., Williston Park, N.Y.
Harold H. Block, '28; March 25, 1983; PO Box 3125, Big Bear Lake, Calif.
Norton M. Case, '28; April 25, 1983; 62 View Crest Dr., Falmouth, Mass.
Francis H. Rutherford, '28; April 18, 1983; Presbyterian Home of South Carolina, CMR-BX 175, Summerville, S.C.
Onnic P. Susmeyan, '28; September 22, 1982; 46 Shornecliffe Rd., Newton, Mass.
Clayton F. Jarvis, '29; May 13, 1983; 2929 Grove St., Sarasota, Fla.
Alwin E. Rigg, '29; April 5, 1983; 64 Havemeyer Ln., Old Greenwich, Conn.
Lloyd W. Vickery, '29; June 2, 1983; PO Box 192, c/o Bickford, Blackwell, Okla.
Robert M. Beyer, '30; February 5, 1983; 24 S Spring St., Concord, N.H.
Rollin L. Rosser, '30; January 8, 1982; 6111 Freeport Dr., Dayton, Ohio.
Eugune A. Silva, '30; October 28, 1982; 124 Myrtle Ave., West Islip, N.Y.
James J. Byrne, '31; March 19, 1983; 257 Sharptown S., Laurel, Md.
Hugo L. Kleinhans, Jr., '31; March 11, 1983; 194 Fairview Ave., Long Valley, N.J.
Judson H. Miskimen, '31; June 12, 1981; c/o Mr. Dale Cox, PO Box 1250, Glendive, Mont.
Tinsley W. Rucker III, '31; March 20, 1983.
Robert W. Baschnagel, '32; September 1981; 586 Halendale Rd., Rochester, N.Y.
James E. Harper, '32; May 8, 1983; 2700 S Grant St., Arlington, Va.
William B. Adams, Jr., '33; April 24, 1983; 1115 Central Ave., Needham, Mass.
John J. Cashman, Jr., '33; April 8, 1983; 415 Orlando Blvd., Indiatlantic, Fla.
John P. Dahlberg, '33; May 3, 1983; 1082 Beecher, Galesburg, Ill.
George D. Huff, '33; May 1, 1983; 148 High Ridge Rd., Ridgefield, Conn.
John T. MacIsaac, Jr., '33; April 19, 1983; RT 2, Box 250, Titusville, Fla.
Gentil P. Reyntjens, '33; June 15, 1973; Bvrd De Tirlemont 25, 3000 Louvain, Belgium.
Theodore D. Hetzel, '34; May 30, 1981; 1334 Burtwood Dr., Fort Meyers, Fla.
James M. Robinson, '34; March 29, 1983; 102 Commonwealth Ave., Alexandria, Va.
Lester Tarnopol, '34; June 1, 1983; 769 Edgewood Rd., San Mateo, Calif.
Richard H. Cook, '35; April 14, 1983; 93 Maple St., Norwood, Mass.
Alfred McDonald, '35; April 11, 1983; PO Box 959, Orleans, Mass.
Thorne W. McWhood, '35; April 4, 1983; 87 Nottingham, Rd., Ramsey, N.J.
John Thorpe, '35; February 26, 1983; 33 Meadow Ln., Chappaqua, N.Y.
Douglas C. Davis, '37; December 23, 1982; 81 Crest Dr., Ephrata, Wash.
Eldon N. Dunlap, '37; November 30, 1982; 2926 S St. Paul St., Denver, Col.
John L. Everett, '37; March 20, 1983.
William E.J. Hammond, '40; April 22, 1983; 111 Mallard Dr., Unionville, Conn.
Bruce T. Benepe, '44; April 3, 1983.
Peter S. Hopkins, '44; April 23, 1983; 44 Three Mile Harbor Dr., East Hampton, N.Y.
Donald A. Tucker, '44; April 25, 1983.
Eleanor M. Cramer, '45; May 9, 1983; 208 Mill Rd., Falmouth, Mass.
George R. Mizer, '45; January 4, 1983; 605 Market, Apt. 1250, C/O J.J. Murray, San Francisco, Calif.
Allan L. Bralove, '46; 1982; 3018 1/2 R St. NW, Washington, D.C.
Angelo R. DelCampo, '48; January 23, 1983; 2917 S. Ocean Blvd., Apt. 1002, Highland Beach, Fla.
Robert Billsbrough Price, '48; September 7, 1981; 4303 Ruston Way, Tacoma, Wash.
Wilbert E. Chope, '49; March 1983; 41 Arvida Pkwy., Miami, Fla.
Louis A. Russell, '50; February 20, 1983; 1650 SW 7th Court, Boca Raton, Fla.
John M. Downie, Jr., '51; May 5, 1983; 122 Schoolhouse Rd., Old Saybrook, Conn.
Reginald A. Barron, '52; February 12, 1983; 62 Horseshoe Rd., Guilford, Conn.
Robert F. Packard, '53; January 20, 1983; Lookout Ln. Little Harbor, Wareham, Mass.
Alan J. Block, '54; April 15, 1983; 4331 Geislen Ctr., Birmingham, Mich.
Robert S. Welter, '56; August 15, 1982; 6413 W. 80th St., Westchester, Calif.
James E. Tillman, '58; March 1981; 1462 38th Ave., Seattle, Wash.
John H. Richardson, '59; March 28, 1983; 719 S. Beverly Glen Blvd., Los Angeles, Calif.
Charles E. George, '61; March 25, 1983; Meridith Neck Rd., Meredith, N.H.
Arthur W. Hatch, '61, October 1982; 7706 Weber St., Annandale, Va.
William L. Eilers, '65; March 9, 1983; Westmoreland Hills, 5305 Elliott Rd., Bethesda, Md.
Michael D. Tetter, '67; April 23, 1983; 6692 Shay Ln., Paradise, Calif.

Courses

I
Civil Engineering

Two members of the faculty—**Steven R. Lerman,** '72, and **Daniele Veneziano,** Ph.D.'74—have been promoted to the rank of full professor. Dr. Lerman, who is head of the Transporation Systems Division, is a specialist in econometric theory and methods applied to transportation, and he maintains close ties with the Sloan School of Management. Professor Veneziano, a native of Italy where he received his undergraduate training, has applied risk and reliability analysis to structural, seismic, and geotechnical problems; he is a member of the Constructed Facilities Division.

Avinash C. Singhal, Sc.D.'61, is associate professor of civil engineering at Arizona State University, Tempe. He has received several research grants from the Engineering Foundation and NSF, contributed several articles to professional journals, and is active in the ASCE Technical Council on Lifeline Earthquake Engineering. . . . **Guy Leclerc,** Ph.D.'73, is currently associate professor of civil engineering at Ecole Polytechnique de Montreal, Canada. . . . **Leonard Lee Dawson,** S.M.'74, reports that he was (for seven years) a project engineer for Top 40 (Enr.), a construction and management firm. Currently he is employed by Exxon Pipeline Co. (as a pipeline engineer), designing piping and associated facilities for the transporation of liquid petroleum, petroelum products, and natural and other gases. He is also a member of ASCE.

Austin W. Betts, S.M.'38, retired from Southwest Research Institute in January 1983. . . . **Norman S. Kram,** S.M.'73, former program manager of The Barkan Companies, Boston, has become its vice-president of marketing, responsible for overseeing new business development as well as supervising the firm's public relations activities. . . **Thomas F. Gilbane, Jr.,** S.M.'75, former vice-president and manager of the Midwestern Region of Gilbane Building Co., Providence, R.I., has become the firm's executive vice-president.

II
Mechanical Engineering

Professors **Klaus-Jurgen Bathe** and **J. Karl Hedrick** have been promoted to the rank of full professor, as of July 1. Professor Bathe, a native of South Africa whose doctorate is from the University of California at Berkeley, is the author of two major textbooks on finite element methods in computational mechanics and a recent winner of ASCE's Huber Research Prize. Professor Hedrick is a specialist in system dynamics and control applied to rail vehicles and has developed important graduate subjects in nonlinear control.

Three members of the department faculty have been promoted to the rank of associate professor:

□ **Maher Ariz El-Masri,** Ph.D.'78, whose work in water cooling of gas turbine blades is widely recognized.

□ **Neville Hogan,** Ph.D.'77, a specialist in motion control and prosthesis design for functionally impaired persons.

□ **Warren P. Seering,** author of a widely known graduate design education program; he has been codirector of the Machine Dynamics Laboratory since 1980.

Professor **Steven Dubowsky,** who joined the M.I.T. faculty a year ago to work in the Systems and Design Division of the department, has been named associate director of the Laboratory for Manufacturing and Productivity. He's known for work in the development of self-learning adaptive control procedures for robotic manipulators and electromechanical systems, and the use of microcomputers for machine and robot control.

Roy E. Rayle, S.M.'49, reports that he is semi retired and is a part-time consultant for ammunition development and a part-time instructor in applied mechanics at San Antonio College, Texas. . . . **James G. Hannoosh,** S.M.'72, writes, "I am currently director of new business development for advanced ceramic components for the High Performance Ceramics Division of the Norton Co., Worcester, Mass. The objective of this new organization is to capitalize on the emerging markets for engineered ceramic materials and components. . . . **Erwin G. Loewen,** Sc.D.'49, program manager at Bausch & Lomb, Rochester, N.Y., has been awarded the 1983 Frederick W. Taylor Research Medal by the Society of Manufacturing Engineers. He was recognized for "his contributions to the science and practice of precision engineering."

Adrain Bejan, Ph.D.'71, professor of mechanical engineering at the University of Colorado, Boulder, last spring delivered the keynote address at the Multi-Phase Flow and Heat Transfer Symposium/Workshop in Miami Beach, Fla. His topic was "Second-Law Aspects of Heat Transfer Engineering." . . . **Charles A. Berg,** Sc.D.'56, has been appointed chairman of the Department of Mechanical Engineering at Northeastern University, Boston. He's has been a consultant since 1974, following service as chief engineer of the Federal Power Commission. . . . **Carl Muscari,** S.M.'74, has been appointed vice-president of manufacturing of Ferrofluidics Corp., Nashua, N.H., responsible for the company's domestic manufacturing operations.

James Marshall Robinson, S.M.'34, a retired Navy admiral who served in the Pacific in World War II and who later joined RCA Systems Engineering, Alexandria, Va., passed away on March 29, 1983. During his military career he received the Distinguished Service Medal and the rank of honorary officer in the Order of the British Empire. He joined RCA in 1956 as a project manager, retiring in 1969, but continued as a consultant until 1982.

III
Materials Science and Engineering

Professor **Samuel M. Allen,** Ph.D.'75, has been promoted to the rank of associate professor in the department at M.I.T.; he's a physical metallurgist known for modeling of transformations and interfacial phenomena.

Maurice E. Shank, Sc.D.'49, director of engineering technology at United Technologies' Pratt & Whitney, East Hartford, Conn., has been elected to the National Academy of Engineering for his "outstanding contributions and technical direction in advancing the state-of-the-art in aircraft gas turbine technology." . . . **Martial P. Corriveau,** S.M.'50, vice-president of the Paul Weir Co., Chicago, Ill., was named the 1982 recipient of the R.A. Glenn Award by the ASTM Committee D-5 on Coal and Coke.

IV
Architecture

Andrew Lippman, '71, director of the Architecture Machine Group in the department at M.I.T., has been promoted to the rank of associate professor, effective July 1. He has made important contributions to interactive computer graphics and has recently been involved in the creation of a new field, computational video.

Ieoh M. Pei, '40, founding partner of I.M. Pei and Partners who is widely honored as one of America's distinguished architects, now holds the 1983 Pritzker Architecture Prize of $100,000; it's one of the most prestigous awards in the profession, often called the "Nobel prize in architecture."

Professor **Otto Piene,** director of the M.I.T. Center for Advanced Visual Studies, was honored twice during the spring. He was the major speaker at an international conference in Salzburg, Austria, on "The Future of the Stage," and he was chairman of the Centennial Tribute to Walter Gropius sponsored by the Goethe Institute and the Boston Public Library.

Alva Tabor III, S.M.'77, is currently employed at Skidmore, Ownings & Merrill, San Francisco.

V
Chemistry

Three members of the department at M.I.T. have been promoted to the rank of associate professor, effective July 1:

□ **Rick L. Danheiser,** who has developed a strong research group on new methods for the synthesis of natural products.

□ **Mary F. Roberts,** whose research is on lipid-protein systems and the responses of cells to chemical and physical modification of their membranes.

□ **William R. Roush,** a biological chemist whose work has focused on organic synthesis and natural products chemistry.

Professor **Klaus Biemann** of M.I.T. is the recipient of a Guggenheim Fellowship for 1983; he'll use it for research on the structure of biologically significant large proteins.

Susan Giller, a graduate student in chemistry in

S. R. Lerman K. J. Bathe

R. L. Jaffe J. D. Joannopoulos

P. C. Joss M. A. Kastner

1972, is a member of the 1983 American Mt. Everest Expedition. The team, including five women, is now attempting the technically demanding West Ridge route.

James J. Bishop, Ph.D.'69, dean of student affairs at Amherst College, Mass., and former associate dean for student affairs at M.I.T., has been appointed vice-provost for university life at the University of Pennsylvania. . . . **Fred A. Bickford,** Ph.D.'33, a retired Corning Glass Works (Corning, N.Y.) research chemist, has been named recipient of the 1983 Eugene C. Sullivan Award by the Corning Section of the American Chemical Society. He was recognized for "long and continuous contributions as a chemist and a scientist . . . credited with key development work on the fused-silica process that has produced mirrors for space and has become the cornerstone for optical waveguide technology."

Joanna F. Shulman, S.M.'65, writes, "Through a complex, very unorthodox, and quite delightful route, I am now a third-year resident physician in obstetrics and gynecology at the Albert Einstein College of Medicine facilities in New York City. A long way from physical chemistry at Tech!" . . . **Donald E. Davenport,** Ph.D.'48, is chief scientist at Tracor MB Associates, San Ramon, Calif. Tracor's headquarters are in Austin, Tex. He recently received a Tracor Innovation Award for significant contributions through leadership in high technology projects of the company, including work with the aluminized glass fiber—Metafil—for such purposes as a filler/reinforcement in plastic materials. . . . **Frederick K. Watson,** Ph.D.'36, reports, "Have been retired from the du Pont Co. for 11 years. Enjoying life in Florida in the winters and New Hampshire in the summers."

Paul C. Panagiotakos, Ph.D.'35, who taught organic chemistry at M.I.T. from 1936 to 1938 and went on to become and head of the chemistry de-

J. K. Hedrick D. Veneziano

partment at Lowell Institute of Technology, passed away unexpectedly on February 27, 1983. He also taught at the New England School of Pharmacy, Boston, the Sorbonne, France, and the University of Baghdad. He was founder of the Frontier Research Co., North Chelmsford, Mass., and served as a consultant.

VI

Electrical Engineering and Computer Science

A specialist in cryptograhy, **Ronald L. Rivest,** associate director of the M.I.T. Laboratory for Computer Science, has been promoted to the rank of full professor effective July 1. Professor Rivest's specialty is in the mathematical basis of computation, and he has made a variety of contributions in theoretical computer science—including the construction of algorithms for the layout of very large-scale integrated circuit chips.

Three promotions to the rank of associate professor also became effective on July 1:

☐ **Randall Davis,** a leading worker in the subfield of artificial intelligence called expert systems.

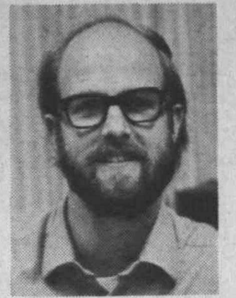
☐ **L. Rafael Reif,** an expert in integrated circuit technology now working on the low-temperature deposition and crystallization of silicon films.

☐ **George C. Verghese,** a theorist whose interest is in applied problems in power systems, power electronics, and machines.

Nancy Ann Lynch, Ph.D.'72, who is Ellen Swallow Richards Associate Professor in the department at M.I.T., has formed a new research group to apply mathematical methods to solving problems in the design of distributed computer systems. The idea, she says, is to identify and solve fundamental problems in communication, coordination of multiple processors, synchronization, timing, concurrency control, and resource allocation in large computer systems.

Complete, unabridged reports, memoranda, idea exchanges, and research findings in the field of artificial intelligence at M.I.T. from 1958 to 1979 are now available on microfiche—over 10,000 pages of memoranda from M.I.T. and similar archives from Stanford (1963-82). The publisher is Comtex Scientific Corp., 850 Third Ave., New York, N.Y. 10022; the price for the M.I.T. collection is $2,450.

Professor **Thomas H. Lee,** director of the Electric Power Systems Laboratory at M.I.T., was the recipient of the Haraden Pratt Award from the Institute of Electrical and Electronic Engineers. He joined the EECS faculty in 1980 and became director of EPSEL in 1982. The award is in recognition for "meritorious service to the Institute, for development of the IEEE Energy Committee, and for promoting public understanding of energy issues." . . . **John H. Scanlon,** '70, has been named director of software development for Data General Corp.'s Westboro, Mass., Systems Development Division, responsible for software development activities. Formerly he was director of the firm's scientific and industrial marketing. . . . **Eugene Stark,** Sc.D.'68, formerly industry liaison officer, has been named industrial initiatives officer at Los Alamos National Laboratory, New Mexico. He also holds an additional post as chairman of the Federal Laboratory Consortium for Technology Transfer, which is sponsored by the



R. L. Rivest R. O. Hynes

National Science Foundation and consists of over 200 laboratories from 11 agencies. **Bernard P. Zeigler,** S.M.'64, a professor at Wayne State University, Detroit, Mich. (since 1981), and an international authority on modelling and simulation, has been named acting chairman of the Computer Science Department at the University.

Kenneth E. McVicar, S.M.'50, former vice-president and general manager of Mitre's C³I Division, has been elected to the new position of vice-president for plans and programs, thus joining Mitre's corporate office. . . . **George B. Hoadley,** Sc.D.'32, reports, "My wife and I enjoyed the "Amazon Passage"—a 1,300-mile cruise from Iquitos in Peru to Manaus in Brazil—last November. This was a promotion of the M.I.T. Quarter Century Club." . . . **David A. Huffman,** Sc.D.'53, has received a "Computer Pioneer Award" of the IEEE Computer Society. . . . **Howard D. Hillman,** S.M.'60, writes, "I was recently appointed manager, corporate information systems, for Charles T. Main, Inc., Boston, responsible for the corporate data center, corporate business systems and office automation."

David I. Kowosky, Sc.D.'52, chief executive officer of the Damon Corp., Needman, Mass., has been elected chairman of the Board of Trustees of Children's Hospital, Boston. . . . **John Preston,** S.M.'54, former engineering manager of Instron Corp., Canton, Mass., has become the corporation's vice-president and director of engineering. . . . **William R. Hewlett,** S.M.'36, has given up his assignment as chairman of the Executive Committee of Hewlett Packard Co., Palo Alto, Calif.; he is now vice-chairman of the H-P Board of Directors. **Carl I. Swanson,** S.M.'53, formerly manager of production engineering and protection systems engineering at Fenwall, Inc., Ashland, Mass., has been named director of quality assurance.

James J. Byrne, S.M.'31, who retired as director of the Engineering Division of the U.S. Forest Service in 1971, passed away on March 19, 1983. In 1967 he was the recipient of the Agriculture Department's Superior Service Award for his involvement in forest engineering. During his employment with the Forest Service, he held a variety of posts in Montana, Oregon, and California, transferring to its headquarters in 1955.

VI-A Program

M.I.T.'s annual Technology day held this year on June 10, saw many VI-A alum's back on campus. Some of those who were seen by John Tucker or who visited the VI-A Office were (starting with the oldest classes and working forward): **Cecil H. Green,** '23, here for his 60th reunion, and responsible for VI-A being at TI, Inc., which he founded; **Chester M. Day, Sr.,** '28, here for his 55th reunion, father of **Chester M. Day, Jr.,** '57, also a VI-A graduate; **John H. Craig,** '38, here for his 45th reunion, chairman of the original organizing group which established Eta Kappa Nu at M.I.T. in 1939 and who served as HKN's national president in 1962; **William E. Northfield,** '56, president of our Eta Kappa Nu Chapter in the fall of 1956; **Raymond S. Stata,** '57, president of Eta Kappa Nu Chapter in the fall of 1957; **Robert L. Baber,** '58, visiting from Europe; **Dean R. Collins,** '58 and **Robert E. Oleksiak,** '58, classmates who stopped by the VI-A office together for an afternoon visit; **Robert B. Parente,** '58; **Michael J. Marcus,** '68; and **Martin P.**

M. L.A. MacVicar

E. Moniz

Lurie, '78, who graduated from Boston University this June with a degree in business administration.

At its annual spring gathering at Endicott House in May, the EECS Department bestowed **M. Mark Colavita**, '80, one of its awards for outstanding teaching along with a much deserved promotion to the rank of Instructor-G.

We note with pride the election of **Lawrence R. Rabiner**, '64, to membership in the prestigious National Academcy of Engineering. Larry is with Bell Laboratories where he did his VI-A work.

Other recent contacts with VI-A alum's include: **David E. Abrams**, '76, with Digilab, Cambridge; **Jeffrey C. Albom**, '81, who visited the office with **Timothy T. Lee**, '79, when both were in Boston on June 3 for a microwave conference. Jeff is now with Watkins-Johnson, Palo Alto, Calif., and Tim with COMSAT Laboratories, advanced microwave department, Clarksburg, Md. Other visitors included: **D. Jonathan Bernays, Jr.**, '79, with IBM's San Jose Research Center, Calif.; **John V. Burroughs**, '81, with Data General Corp., Marlboro, Mass.; **Leonard N. Evenchik**, '77, with Bolt Beranek and Newman, Cambridge; **Alan M. Marcum**, '78, who is with Hunter and Ready, Palo Alto, Calif.; **K. Alexander McDonald**, '81, who called to say he is now in sales with Hewlett-Packard, Houston, Tex.; **Louis A. Nagode**, '80, from whom we received a note telling of his first child, a daughter, born on April 8, 1983. Louis is still with Hewlett-Packard's Colorado Telecommunications Division, Colorado Springs; and **Richard A. Ulene**, '74, who obtained his M.D. from the University of Southern California this May. Congratulations!—John A. Tucker, Director, VI-A Program, Room 38-473, Cambridge, MA 02139

VII
Biology

Richard O. Hynes, Ph.D.'71, codiscoverer of the glycoprotein fibronectin, has been promoted to full professor in the department effective July 1. Dr. Hynes is on the editorial boards of three journals—*Cell, Developmental Biology*, and *BBA Review on Cancer*, and he is organizing a 1984 Gordon Conference on animal cells and viruses.

To recognize outstanding undergraduate teaching, Professor **Frank Solomon** was cited in May 1983 for a Science Council Prize by John M. Deutch, '61, dean of the School of Science. The "excitement, enthusiasm, and clarity" of his lectures in the course in general biochemistry won the citation for Professor Solomon.

VIII
Physics

Six members of the department at M.I.T. have been promoted to the rank of full professor effective July 1: **Robert L. Jaffe, John D. Joannopoulos, Paul C. Joss, Marc A. Kastner, Margaret L.A. MacVicar, '64,** and **Ernest Moniz**. Professor Jaffe is a theoretical particle physicist who has made seminal contributions to the understanding of hadron structure of dynamics. A condensed matter theorist, Professor Joannopoulos is interested in the development of theoretical methods to study real materials, hav-

B. Harrison

L. E. Susskind

ing made major contributions to the physics of elementary excitations of bulk solids, their surfaces and defects. Professor Joss, a theoretical astrophysicist, holds the 1980 Warner Prize of the American Astronomical Society for his work showing that thermonuclear flashes in the surface layers of accreting neutron stars could account for cosmic x-ray bursts; he has also done theoretical studies of compact binary stellar systems. Professor Kastner is an experimental solid-state physicist whose work has been concerned primarily with electronic and optical properties of amorphous semiconductors. Professor MacVicar, who also holds the Cecil ('23) and Ida Green Chair in Education, is founding director of UROP, and she has also contributed to superconducting materials research. An authority on the use of electromagnetic probes of nuclei, Professor Moniz is recognized for work in theoretical nuclear physics—notably the interaction of pions with nuclei.

Two promotions to the rank of associate professor became effective on July 1:

□ **James G. Branson**, an experimental particle physicist with current research commitments at both CERN (Geneva) and PETRA (Hamburg, Germany).

□ **Richard J. Cohen**, Ph.D.'76, who has been studying physical problems with significant clinical applications as a member of the Harvard-M.I.T. Division of Health Sciences and Technology.

Professor **Robert L. Jaffe** was cited for outstanding undergraduate teaching in May 1983 with one of two inaugural Science Council Prizes given by **John M. Deutch**, '61, dean of the School of Science. Student and faculty nominees said he presented a "model of the best kind of university teaching."

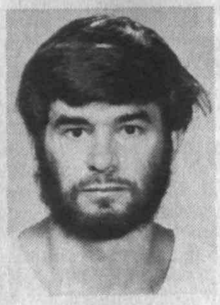
IX
Psychology

Professor **Richard Held**, head of the department at M.I.T., has been awarded the 1983 Howard Crosby Medal by the Society of Experimental Psychologists. He was recognized for "his meticulous and imaginative research on the genesis of spatial vision and visually guided behavior . . . and his work (that) provided eye care specialists with new tools in the treatment of visual problems. . . . **Marianne Wiser**, Ph.D.'81, has been appointed assistant professor of psychology at Clark University, Worcester, Mass.

X
Chemical Engineering

Robert B. Flanders, S.M.'58, reports, "Reached age 67 and still going strong at NRC, Inc. Just hired my protege. Plan to work him up so that I can start to reduce my own work hours—then retire at 70. I will continue a while on retainer until I get too old to work anymore." . . . **Pope A. Lawrence**, S.M.'37, has retired after 38 years of active duty as a commissioned officer in the United States Public Health Service.

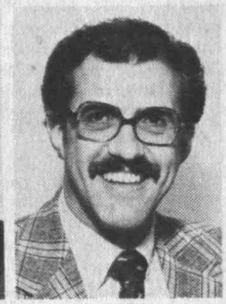
On April 6, 1983, an article appeared in the Brookfield (Conn.) Journal, written by a fifth-grade student depicting his adoration and feelings towards "a special friend," and math teacher, **Anthony Standen**, S.M.'29. Anthony worked in England for several years and then came to America and worked for John Wiley and Sons, Inc., New York City, retiring in 1971. Following retirement he decided to teach students mathematics at the Kent Center School. "The advantage," he told the principal, "is that I will work for you for free, and the disadvantage is that I am hard of hearing." As quoted by the writer of this article, "Ever since I entered his class, my interest in math has risen greatly. . . . His long white beard and his tweedy mustache give him a look of knowledge and magnificence which kind of remind me of math itself."



P. H. Molnar

S. C. Solomon

C. Chryssostomidis



J. G. Fox

S. Erdely

N. Block

XI
Urban Studies and Planning

Two members of the M.I.T. department have been promoted to the rank of full professor effective July 1: **Bennett Harrison**, an economist whose studies have concerned the changing distribution of employment and income, and **Lawrence E. Susskind**, Ph.D.'73, a specialist in environmental and community development management. Professor Susskind was head of the department from 1978 to 1982, and he is now directing an interuniversity study of "tax cap" effects in Massachusetts; Professor Harrison is co-author of *The Deindustrialization of America*.

James E. Wallace, Ph.D.'72, reports that for the 1981-82 term he was chief policy analyst for the President's Commission on Housing, and he is currently project director for Abt Associates, Inc., Cambridge, on a national evaluation of the HUD Fair Housing Assistance Program. . . . **Henry Cohen**, M.C.P.'44, dean of the Graduate School of Management and Urban Professions at the New School for Social Research, will resign—after 15

years of service—on December 31, 1983. He will remain at The New School as professor of management and urban affairs. . . . **George S. Gatter,** M.C.P.'51, has completed the economic development plan for the Channel Island Harbor Destination Resort. The plan identified $400 million in annual business and industrial expansion potential.

Jane S. Rodman, M.C.P.'40, of Millers, Md., passed away on February 26, 1983; no details are available.

XII

Earth, Atmospheric, and Planetary Sciences

William F. Brace, '46, Cecil and Ida Green Professor of Geology, formerly head of the Department of Earth and Planetary Sciences, became head of the new Department of Earth, Atmospheric, and Planetary Sciences on July 1, 1983. This single new department resulted from the merger of Courses XII and XIX. It contains a Center for Meteorology and Physical Oceanography, which will be directed by Professor **Peter H. Stone,** formerly head of the Department of Meteorology and Physical Oceanography. The new department will have approximately 40 faculty members, 180 graduate students, and 45 undergraduate majors.

Martin J. Buerger, '25, Institute Professor and professor of mineralogy, emeritus, and his wife Lila, were the honor guests at a mid-April dinner at the M.I.T. Faculty Club. Some 20 guests—former students and friends—joined Martin in celebrating his 80th birthday. He is busily working on his 13th book, *Image Space*. . . . **Martha (Redden) Kimball,** '67, who arranged the foregoing Buerger dinner, is now employed in New York City, in the American Museum of Natural History's Department of Mineral Sciences. . . . **Patrick M. Hurley,** Ph.D.'40, now professor of geology, emeritus, divides his time between his Florida and New Hampshire residences, depending on the season. He recently published a popular book, *Living with Nuclear Radiation* (University of Michigan Press), which was written specially for the informed non-professional.

Giorgio Fiocco, formerly a faculty member of the Geology Department, is now with the Centro Nazionale per la Fisica dell'Atmosfera e Meteorologie, Consiglio Nazionale delle Ricerche, in Rome, Italy. He also has part-time appointments at the University of Rome and the University of L'Aquila. . . . **William B. Farrington,** Ph.D.'53, accompanied by his wife Trudy, visited the Boston area in early June and reported that his work as a certified financial analyst (CFA) keeps him shuttling between his office in Laguna Beach, Calif., and Wall Street. . . . **Stanley J. Laster,** Ph.D.'70, is now manager of geophysical research, with Mobil Research and Development Corp., Dallas Research Division, Farmers Branch, Tex., 75234.

Frank T. Wheby, '52, writes that he enjoys reading the Class Notes in *Technology Review*, and reports that he is successfully engaged in individual practice in civil and geotechnical engineering. He lives with his wife Judith and two teenagers, Chris and Jon, at 1319 Grant St., Evanston, Ill., 60201. . . . **Wallace W. Wrigley,** who took his first two years of geology in Course XII, is now assistant divisional geophysicist in the Austral-Asia-Far East Division, Occidental Exploration and Production Co., with headquarters in Bakersfield, Calif. He and his wife Diane, and their two daughters, Christine and Katherine, live at 1405 Corte Canalate, Bakersfield, Calif., 93309.

Robert A. Phinney, '58, now professor of geophysics at Princeton University, attended the alumni activities in June and brought us up to date on his current academic work. He was accompanied by his wife Caroline. . . . **Otto von der Heyde,** who set up the first machine shop in the Geology Department and then served as our first Instrument Maker until 1934, when he resigned to establish his own shop, died on January 23, 1983. His home was at 95 Concord Rd., Weston, Mass., 02193. Students of his time will remember his skill at the piano as well as at the lathe and drill press.

Volume II of my *Geology at M.I.T. 1865-1965* was published in November 1982, by the M.I.T. Press, and completed my history of our department, a writing project started when I reached retirement age in 1970.—Robert R. Shrock, Professor Emeritus, 18 Loring Rd., Lexington, MA 02173.

Two promotions to full professor became effective in the new department on July 1: **Peter H. Molnar,** a physical geologist, and **Sean C. Solomon,** Ph.D.'71, an expert in plate tectonics and seismology. Professor Molnar's research contributed to the development of plate tectonic theory, and he has been a leader of undergraduate and graduate education in this field. Professor Solomon is the designer of an ocean-bottom seismometer for studies of earthquakes at mid-ocean ridges, and he has also studied the tectonic history of the Moon, Mercury, Mars, and Venus.

Three promotions to associate professor also became effective on July 1:

☐ **Mark A. Cane,** Ph.D.'76, a theoretical oceanographer and meteorologist whose work has centered on equatorial ocean dynamics.

☐ **Charles C. Eriksen,** Ph.D.'77, a physical oceanographer and expert in modelling dynamic marine phenomena.

☐ **Frank S. Spear,** a geologist whose major effort has been on understanding the genesis of metamorphic rocks.

Most alumni will be aware of Professor **William F. Brace**'s prowess as a long-distance runner, but now most of the nation will join them: Professor Brace is M.I.T.'s nominee for its outstanding amateur athlete in Wheaties' nationwide "Search for Champions" contest. Ballots for the contest are available only on Wheaties box tops. There will be 50 winners, each awarded $1 per ballot to be given by Wheaties to the philanthropy of the winner's choice, and six of the 50 finalists will appear on future Wheaties boxes. Professor Brace is active in competitive rowing, running, and mountaineering as well as long-distance running.

XIII

Ocean Engineering

Professor **Chryssostomos Chryssostomidis,** Ph.D.'70, director of the M.I.T. Sea Grant Program, has been promoted to the rank of full professor, retroactive to July 1, 1982. Professor Chryssostomidis is noted for work on the design of marine vehicles and systems, and he is intimately involved with planning and development of the undergraduate program.

Three members of the department at M.I.T. have been promoted to the rank of associate professor, effective July 1, 1983:

☐ **Harilaos N. Psaraftis,** Ph.D.'77, a specialist in naval logistics scheduling problems, planning for oil spill clean-up, and analytical methods in ocean acoustic detection.

☐ **Michael S. Triantafyllou,** Sc.D.'79, known for pioneering research on underwater vehicles and cable dynamics; other fields of interest are the dynamic positioning of drill ships, prediction of ship motions, and deep-ocean mining evaluation.

☐ **Paul C. Xirouchakis,** Ph.D.'78, an internationally recognized authority in the structural design of ship and offshore facilities, including marine structures in ice environments.

Professor **J. Kim Vandiver,** Ph.D.'75, has been honored by the Petroleum Division of the American Society of Mechanical Engineers for the best paper at the 1983 Offshore Technology Conference in Houston. It was the ASME's first presentation of the new Arthur Lubinski Award, made for Professor Vandiver's paper on "Drag Coefficients of Long Flexible Cylinders."

Edward McCann, S.M.'70, has recently been promoted from the corporate planning staff to coordinator of offshore construction for Standard Oil Co. of California. . . . **Theodoros Achtarides,** S.M.'73, assistant professor at Stevens Institute of

Technology, Hoboken, N.J., has received a grant from the Ship Structure Committee (a federal committee of maritime agencies) for a nine-month study to determine formulas to predict the vertical vibration of ships. **Halsey Herreshoff,** S.M.'60, president of Halsey Herreshoff Design, Inc., Bristol, R.I., was speaker at a chapter meeting of the New England Chapter of the Smaller Business Association last March. His talk was on the maritime industry in Southeastern New England. He is a yacht designer of note in his own right and has been involved in five America's Cup campaigns.

Henry Nardone, '52, was the recipient of the 1982 YMCA Service to Youth Award, for his efforts on behalf of the young people in Westerly, R.I. . . . He has served on the Westerly School Committee for 17 years (10 years as chairman and vice-chairman), along with several other school associations.

William Jennings Malone, S.M.'21, a retired Navy captain who spent most of his career at the Bureau of Construction and Repair in the Navy Department, Washington, D.C., passed away on March 14, 1983. He supervised the design and construction of several "Essex"-class aircraft carriers during World War II and retired as inspector of naval materials in 1957, when he moved to Florida.

XIV

Economics

Paul W. MacAvoy, who was professor of economics at M.I.T. from 1963 to 1975 before he was called to join the President's Council of Economic Advisers, is now dean of the Graduate School of Management at the University of Rochester. Since leaving Washington, he has been a member of the Yale economics faculty.

Professor **Franklin M. Fisher** of M.I.T. is the senior author, with John J. McGowan and Joen E. Greenwood, of *Folded, Spindled, and Mutilated: Economic Analysis and U.S. v. IBM* (M.I.T. Press, 1983, $25). The book is a summary of IBM's defense against the government's monopoly suit brought in 1969, but—says Professor Carl Kaysen, director of M.I.T.'s Program in Science, Technology, and Society in his foreword—it has broader significance: "The dynamic interaction of technical progress and market competition is of great theoretical and practical interest—(especially in) one of the most rapidly advancing and broadly significant technologies in today's economy."

Timothy J. Kehoe, a major figure in his age group in mathematical economics and general equilibrium analysis, has been promoted to the rank of associate professor at M.I.T., effective July 1.

Frank C. Colcord, Ph.D.'64, writes, "I've been keeping very busy as dean of the faculty of arts and sciences at Tufts University, Boston." . . . **Stephen A. Resnick,** Ph.D.'64, has been promoted from senior investment strategist to acting chief investment strategist at Merrill Lynch, Pierce, Fenner & Smith, New York City. . . . **Jaleel Ahmad,** Ph.D.'65, reports, "My latest book, *Floating Exchange Rates and World Inflation*, is scheduled for publication this year by MacMillan Press, London." . . . **Morrison H. Beach,** '42, writes, "Recently retired, but active in organizations for retired people, including being a delegate to the United Nations World Assembly on Aging in Vienna. Am chairman of the Connecticut Higher Education Supplemental Loan Authority and chairman of the Kingwood-Oxford School, among other things."

XV

Management

Owen B. Butler, chairman of Procter & Gamble, made headlines in the Boston papers when he spoke to a Sloan School convocation late last spring. His principal message was that U.S. corporations need to be more responsible citizens—to have more concern about the quality and usefulness of their products, to be more public spirited in their adverstising and moral in their product promotion. But the ultimate test is still the bottom line of the financial statement. "Bankrupt companies," said Mr. Butler, "cannot support education or the arts."

Four members of the Sloan School faculty have been promoted to the rank of associate professor, effective July 1:

☐ **Mel Horwitch,** a student of the management of large-scale technological projects and corporate strategy.

☐ **Harry C. Katz,** a labor economist who has studied the interplay between institutional and market forces in the labor market.

☐ **James B. Orlin,** a major contributor to optimization theory who worked on scheduling problems in production management and transportation planning.

☐ **M. Anthony Wong,** a statistician, whose work is in both statistical methodology and its applications to management and the health sciences.

Karl A. Miller, S.M.'63, has organized David Goliath, Ltd., to own and operate electronic and print media. . . . **Riva Poor,** S.M.'71, "a professional problem solver" in Cambridge, is the director of the hospitality program "Bed and Breakfast of Cambridge and Greater Boston." The program is designed for businesspeople and professionals who "want comfortable accommodations in a central location and vactioning couples who desire to 'get away' " in a home setting. For a fee less than that charged by many hotels, a room is provided by the host family and breakfast offered. Apartments are also available for those who need to be in the area for a longer period (up to one month). . . . **Linda S. Marks,** S.M.'82, reports that she is presently a management consultant at Digital Equipment Corp. and is also a professional songwriter/musician, performing in the Cambridge area at Passim, the Nameless Coffeehouse and WERS radio.

Edward D. Rich, S.M.'34, of Ventura, Calif., passed away on March 9, 1983; no details are available. . . . **Rudolf K. Schmid,** S.M.'65, of Forch, Switzerland, died tragically while skiing on a glacier on March 12, 1983. He was described in a letter from the M.I.T. Club of Switzerland as "one of our most loyal founding members of the club . . . he came to virtually every gathering, with his family, and was an officer for some years as well. His spirit and devotion to both the club and to M.I.T. will be sorely missed." . . . **Otto H. Poensgen,** S.M.'59, a chaired professor in industrial management at the University of Saarland, Saarbruecken, Germany, passed away on October 29, 1982. He was renowned for his research and teaching in management science, business strategy, and organizational structure. During a sabbatical leave in 1980, he continued his research at M.I.T. He served as dean at Saarland, chaired many faculty groups in Germany, and was an active member of many international and professional groups.

Sloan Fellows

A. Edward Allison, S.M.'71, has been promoted from senior vice-president to executive vice-president of the Chase Manhattan Bank, N.A., New York City. . . . **John W. Anderson,** S.M.'67, president of GTE Lighting Products, a subsidiary of the GTE Corp., Stanford, Conn., is retiring from this post. . . . **Matthew E. Anderson,** S.M.'80, reports that he was selected for a position as assistant technical director for development and head of the Fuze and Sensors Department at the Naval Weapons Center, China Lake, Calif. . . . **Avi Frydman,** S.M.'81, is currently with management sciences at Digital Equipment Corp.

Marvin G. Kirby, S.M.'72, former regional manager of the IBM Corp., has become vice-president of domestic sales of Prime Computer, Inc., Natick, Mass. . . . **Charles E. Craig,** S.M.'72, former general manager of international operations at the Timken Co., Canton, Ohio, has become its vice-president of international operations. . . . **Witt I. Langstaff,** S.M.'65, has been appointed director of product resources at the Eastman Chemicals Division of Eastman Kodak Co., Kingsport, Tenn. Formerly, he was superintendent of Kodel Fiber Division of Tennessee Eastman Co.

Gary Frashier, S.M.'70, executive vice-president of the Millipore Corp., president of Waters Associates, Inc., and Continental Water Purification—the latter two subsidiaries of Millipore—has been named a "distinguished engineer" by the Texas Tech University College of Engineering. . . . **Michael Bruce,** S.M.'76, has recently been promoted to vice-president of business plans for IBM Europe, Paris. . . . **Colby H. Chandler,** S.M.'63, President of Eastman Kodak Co., is now a director of Ford Motor Co., Dearborn, Mich. . . . **Oliver C. Boileau,** S.M.'64, president of General Dynamics Corp., St. Louis, Mo., has been elected a corporation member of the Lawrence Institute of Technology, Southfield, Mich. As a corporation member, he will assist in choosing the Board of Trustees and advancing the goals of the 5,800-student private college.

Senior Executives

John H. Richardson, '59, president of the Hughes Aircraft Co., passed away in March 1983. He was employed with Hughes for almost 35 years and became president in 1978. He was a member of the Chancellor's Associates of the U.C.L.A. Foundation and an honorary professor of the Defense Systems Management College.

Management of Technology Program

Charles A. Berry, S.M.'83, has returned to Pilkington Brothers Ltd., and has taken a position in Scotland as technical director for one of the companies in the electro-optical division. . . . **Carol M. Lemlein,** S.M.'83, has gone back to California to be with her daughters and has accepted a position of software manager with Teradyne Inc. in Woodland Hills. . . . **Jerome P. Sutton,** S.M. '83, has selected a position at Wright-Patterson Air Force Base in the aeronautical systems division, as a systems engineering manager.

XVII

Political Science

Two members of the department faculty have been promoted to associate professor, effective July 1:

☐ **Stephen M. Meyer,** a specialist in national security affairs; he's recently completed studies on nuclear proliferation and Soviet defense policies.

☐ **Brian H. Smith,** a Roman Catholic priest for a number of years before completing his doctorate in political science at Yale in 1979; he is a specialist in church-state relations in Latin America.

Professor **Harvey Sapolsky** is director of a three-year study of a medical care pricing system—under which hospitals receive fixed rates for diagnosed problems rather than varying rates depending on services rendered—now in use in New Jersey. The analysis will be financed by a $700,000 grant from the Robert Wood Johnson Foundation to M.I.T.'s Laboratory for Health Care Studies.

XVIII

Mathematics

Promotions to the rank of associate professor were announced for two members of the department at M.I.T. last spring, both effective on July 1:

☐ **Sy D. Friedman,** a mathematical logician whose main interest is in the application of set-theoretic methods to higher recursion theory.

☐ **Michael Spiser,** a computer scientist whose special field is in the complexity of computations.

Richard P. Stanley, professor of applied mathematics in the department at M.I.T., has won a

Guggenheim Research Fellowship for 1983; he'll use it for studies in interactions between combinatorial mathematics and representation theory.

Frank Warner, Ph.D.'63, professor of mathematics (since 1968) at the University of Pennsylvania, Philadelphia, has been named one of the two first recipients of the Ira Abrams Memorial Award for Distinguished Teaching at the university. Among his involvements at the University he has served as undergraduate chairman of the Mathematics Department, a member of the Faculty of Arts and Sciences Advanced Planning Committee, and the Joint Committee. He also holds membership in various mathematical societies.

XX
Nutrition and Food Science

Professor **James G. Fox** of the Division of Comparative Medicine has been promoted to the rank of full professor in the department as of July 1. A veterinarian, Dr. Fox came to M.I.T. in 1974 to be director of the Animal Care Facilities, and his research on the development of animal models as analogs of human disease and diseases that are transmissible to humans has been widely noted.

A promotion to the rank of associate professor at M.I.T. has come to **Alexander M. Klibanov,** a specialist in applied enzymology, including the development of novel applications of enzymes as catalysts in organic reactions.

Nevin S. Scrimshaw, professor and director of the M.I.T.-Harvard International Food and Nutrition Program, has been awarded an honorary doctor of science degree from Mahidol University, Bangkok, Thailand.

XXI
Humanities

Professor **Stephen Erdely,** a violinist who was head of the Music Section from 1976 to 1981, has been promoted to full professor in the department effective July 1. Professor Erdely, who has performed with his wife as the Erdely Duo since 1952, is responsible for a fundamental course in the music curriculum and has introduced subjects in ethnomusicology, his specialty, as well as in music history and literature.

Two members of the department at M.I.T. have been promoted to associate professor:

☐ **Julia Alissandratos,** a specialist in modern languages whose research is on medieval Slavic eulogistic texts in their relationships with earlier Byzantine traditions.

☐ **David M. Halperin,** a member of the Literature Section with wide-ranging interest in the classics.

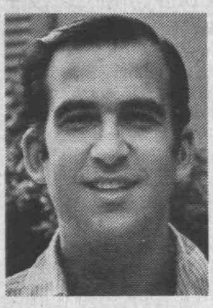
XXIV
Linguistics and Philosophy

Ned Block, '64, one of the leading exponents of the new field of the philosophy of psychology, has been promoted to the rank of full professor in the department effective July 1. In ten years he has become a central figure in the development of interdisciplinary research in cognitive science at M.I.T., and he was president in 1979-80 of the Society for Philosophy and Psychology.

Technology and Policy Program

Newton de Castro, S.M.'81, has recently completed his Ph.D. at M.I.T. and has returned to Rio de Janeiro to teach transportation. . . . **Roger Kilgore,** S.M.'81, has accepted a new position with GKY Associates, Washington, D.C., where he is working with the data and environmental monitoring division of the Environmental Protection Agency. . . . **Sudhakar Kesavan,** S.M.'83, will join ICF, Washington, D.C., in September.

Now Math Is for Money



Allan J. Gottlieb, '67, is associate research professor at the Courant Institute of Mathematical Sciences of New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y., 10012.

A recent speed problem has provoked Albert Mullin to offer cash prizes for solutions to two related problems. Such individually funded prizes are not unprecedented; indeed, the famous mathematician Paul Erdos has been doing it for years. Mr. Mullin writes:

"John Linderman's speed problem **M/J SD2** (*May/June, 1983, p. A14*) has other interesting aspects that may amuse the readers of 'Puzzle Corner.' Not only are products of two distinct primes connected in nontrivial ways with M.I.T.'s version of public-key cryptosystems (so-called RSA public-key cryptosystems), but the present year and the past two years in the ordinary calendar (yet another *three* consecutive numbers) are products of two distinct primes, too. Thus:

1981 = 7 × 283
1982 = 2 × 991
1983 = 3 × 661

Another such triple of years occurred during World War II:

1941 = 3 × 647
1942 = 2 × 971
1943 = 29 × 67

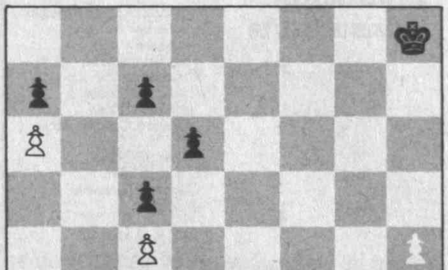
Surely such triples of consecutive numbers have a role in a deep study of the Cabala!

"I will donate $50 to the M.I.T. Alumni Fund for a proof that there exist infinitely many triples of three consecutive positive integers which are products of two distinct primes.

"Further, it can be shown that if a positive integer n is a product of two primes that differ by $d \geq 1$, then $\varphi(n)\sigma(n) = (n - d - 1)(n + d - 1)$, where φ is Euler's totient and σ is the sum-of-divisors function. I will donate $100 to the M.I.T. Alumni Fund for a proof that the *converse* holds for infinitely many $d \geq 1$."

Problems

A/S 1 We begin with a chess problem from Bob Kimble:



White is to play and draw. At first it looks too easy: with material balanced and White possessing the only passed pawn, perhaps he should win—not just draw. But watch out for the Black central pawn mass.

A/S 2 Donald Richardson asks us a variation on a well known mathematical game, the "2-3-4-5 coin game." He writes:

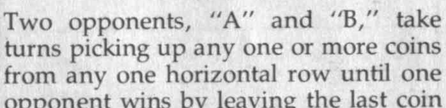
To play the game, 14 coins are arranged in four horizontal rows with 2, 3, 4, and 5 coins, respectively:

● ●
● ● ●
● ● ● ●
● ● ● ● ●

Two opponents, "A" and "B," take turns picking up any one or more coins from any one horizontal row until one opponent wins by leaving the last coin for the other opponent to pick up. If "A" starts, there will be no way for "A" to win regardless of his first move, unless "B" fails to make the right moves thereafter. The problem is to identify how few and what configurations "B" can leave for "A" on "B"'s first move (after any starting move by "A") so that "B" can win, regardless of any subsequent move by "A."

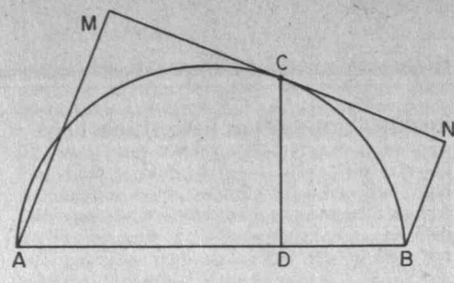
A/S 3 The following puzzle made its *Technology Review* debut in 1942 as part of an advertisement for Caldron Products, Inc.:

The diagram indicates schematically a little problem encountered in our shop a short time ago.



A member A moves on rollers, without slipping, from the solid-line position to that shown in dotted lines. What is the value of X in terms of the lengths A and B?

A/S 4 A geometry problem from Mary Lindenberg:



In the drawing, C is a point on the semicircle with AB as diameter. MN is tangent to the semicircle at C. AM and BN are perpendicular to MN, and CD is perpendicular to AB. Show that CD = CM = CN and that $CD^2 = (AM)(BN)$.

A/S 5 A numeric problem from Susan Henrichs:
Which integers X have the property that 9X is the same as X with the digits in reverse order? There is one other integer multiplier (besides 9 and trivially 1) that reverses digits for an infinite number of integers. What is this multiplier and what are the multiplicands?

Speed Department

A/S SD1 Art Delagrange proposes the following variation on **FM SD1**:
If a 10-by-30-by-1-foot flat-bottomed rectangular barge is in a lock and a 100-cubic-foot chest with a specific gravity of 4 is thrown overboard, what is the change in water level?

A/S SD2 We close with a bridge quickie from Doug Van Patter:

With the hands shown, you and your partner have reached a six-no-trump contract:

♠A K 10
♥A 7 3 2
♦A Q J 9 8
♣K

♠Q J 5
♥K 5 4
♦10 6 2
♣A 9 6 4

The bidding: one diamond, two clubs (you), four no-trump, five diamonds (one ace), six no-trump. The ♠8 (opening lead) is taken with your ♠Q. You play the ♦10—East shows out! You take a second finesse and cash the ♣K—West shows out! Back to your hand with the ♥K. You cash the ♣A, discarding a heart from dummy. Now you finesse diamonds for the third time. What is the best shot at making this contract?

Solutions

APR 1 Find a bridge deal such that four spades, when played from *any* position, will be set at least seven tricks (i.e., the defense will make four spades).

L. Steffens liked this one because it was a problem that he could handle but the expert among his bridge buddies couldn't. The following solution is from Lawrence C. Kells:

I was fascinated to see that this is a retrograde

bridge problem—that is, instead of presenting a hand and asking how to reach a particular result, you give the result and ask how to reconstruct the hand. I have doodled some on this kind of problem so I immediately tackled this one. I guessed that the key was that one player had the top spades and high cards in other suits to cash after drawing trumps if he were on lead, but that he would lose his high cards to a crossruff if he weren't. The solution then fell into place:

	♠5 4 3 2 ♥2 ♦5 4 3 2 ♣5 4 3 2	
♠J 10 9 ♥— ♦J 10 9 8 7 6 ♣A K Q J		♠8 7 6 ♥J 10 9 8 7 6 5 4 3 ♦— ♣10
	♠A K Q ♥A K Q ♦A K Q ♣9 8 7 6	

If North or South is declarer, a club lead allows West to take four tricks, after which the defense cross-ruffs six tricks in diamonds and hearts, while South follows and North cannot overruff. South gets only his three top spades. If East or West is declarer, a spade is led and South draws trump in three rounds. Then South can cash his six side-suit winners. North's remaining trump is the tenth trick for the defense.

Thus four spades from any position is defeated seven tricks.

L. Steffens and Stephen Canter noticed that slightly rearranging the diamonds (give North the ♦Q and ♦J, West the ♦3 and South the ♦2) enables North-South to set the contract one more trick.

Also solved by Matthew Fountain, Phillip Dangel, Doug Van Patter, and the proposer, Arthur Polansky.

APR 2 Shown below is a simple word square:

```
A C E
P A R
E R A
```

We could fill the plane with such word squares so that every cell of an infinite grid lay at the intersection of two words. However, such an arrangement would have two defects: (1) the pattern would be repetitive, and (2) the words would not all be interconnected. Show how these defects can be fixed; i.e., fill the plane with an infinite number of words so that the pattern does not repeat in any row or column, every cell lies at the intersection of two words; and every word is connected to every other one by a chain of intersecting words. Do not use any two-letter words.

Matthew Fountain gave a solution involving the group-theoretic definition, and Richard Hess submitted the following:

```
     n              k
ATE...ATEASEATE...ATEASE
TE...ATE
E...ATE
ATE
TE
A
```

The above pattern repeated indefinitely with n and k varied randomly (between 1 and 10, say) will satisfy the conditions of the problem:

T: Always at the crossing of ATE and ATE.

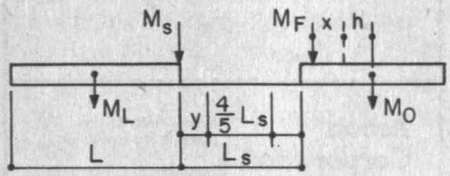
A: At the crossing of EAT and EAT or TEASE and TEASE.

S: At the crossing of TEASE and TEASE.

E: At the crossing of TEA and TEA or TEASE and TEASE.

APR 3 One afternoon in a swamp Sneaky the snake, whose mass is M_s and length ℓ_s, was resting on the left end of a log of length L and mass M_L when he suddenly remembered that he was hungry. After a few moments, he found Freddy the frog sitting on a large disk-shaped leaf of radius R and mass M_0 h cm. away from the center of the disk. Initially the disk was 4/5 ℓ_s cm. away from the right end of the log. Sneaky started moving toward Freddy, and Freddy (who was ignorant of the laws of physics) started jumping for his life. However, when Freddy remembered that Sneaky had his best friend for breakfast that morning he was overcome by rage and desire for revenge, and he turned around to charge against Sneaky. Normally it would have been a dumb move, but the laws of physics reward the courageous: when Freddy stopped at a point on the disk and realized that his attempt was futile if not suicidal, the disk was just out of the reach of Sneaky, who was on the right end of the log by that time. Sneaky could not swim, so the good guy was saved and the bad guy had a hungry afternoon. Can you locate the spot where Freddy stopped? Assume all motions occurred on a line and the water offered no resistance. Both the log and disk have a uniform mass density.

The following solution is from Harry Zaremba:



In the drawing, assume M_F is the mass of the frog and let x, y, and z be the distances moved by the frog, log, and leaf, respectively, from their original positions. If the velocity of the snake along the log is $V_s = L/t$, the impulse forces between the snake and log will impart a velocity of $V_L = y/t$ to the combined mass of the snake and log. The distance y is in the opposite direction to the snake's motion. By conservation of momentum,

$M_sV_s = (M_s + M_L)V_L$

Substituting the velocities,

$M_sL = (M_s + M_L)y$, or

$y = M_sL/(M_s + M_L)$.

Applying the same principle to the frog-leaf system,

$M_Fx = (M_F + M_0)z$,

in which z is the distance moved by the combined mass of the frog and leaf in a direction opposite to x. Thus,

$z = M_Fx/(M_F + M_0)$.

From the figure,

$y + z + 4L_s/5 = L_s$.

Substituting y and z, the solution for x becomes

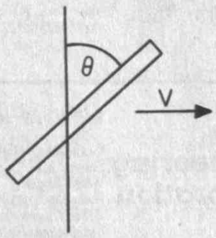
$x = (M_F + M_0)/M_F \cdot [L_s/5 - M_sL/(M_s + M_L)]$.

Also solved by Leo Harten, Harry Zaremba, Michael Jung, and the proposer, Ming Chung.

APR 4 Assuming the sudden onset of steady rainfall, will a person remain dryer by walking or running any given distance to shelter?

Richard Hess believes in running in the rain. He writes:

If you can orient your body at will it is best to run as fast as possible.



Model yourself as a long rectangular solid with end cross area A. If you can move at velocity v you should orient yourself at

$$\theta = \tan^{-1}\left(\frac{v}{v_{rain}}\right)$$

so as to only get the small end wet. The total water received is that in a volume

$V = Atv/\sin\theta$,

where t is the time spent in the rain. But

$t = d/v$

where d is the traveled distance; and

$V = Ad/\sin\theta$.

This becomes less as θ gets larger, and thus
$v = v_{rain} \tan \theta$
should be made as large as possible.

Matthew Fountain notes that with an umbrella it is best to go slow and notes that when he is stuck in the rain it's the inside surface of his glasses that gets wet. Although Fountain says his friends dispute this, I have the same experience. Judith Longyear observes that *"no* animal moves slowly through rain!"

Also solved by Harry Zaremba.

APR 5 Find positive integers a, b, and c such that $a^3 + b^4 = c^5$.

Although no one was able to prove that all solutions had been found, David and Nancy Leblanq (among others) found infinitely many. They write what they call "a computer scientist's solution": Assume a, b, and c are powers of 2. This transforms the problem into
$2^{3x} + 2^{4y} = 2^{5z}$.
(This limits the solution space.) 2^{3x} must equal 2^{4y} in order to sum to a power of 2 (in this case 2^{5z}). Thus $3x = 4y$.
$2^{3x} + 2^{4y} = 2^{3x} + 2^{3x} = 2^{3x+1} = 2^{5z}$
Thus $3x + 1 = 5z$. $3x = 4y$ for all q such that $x = 4q$ (and then $y = 3q$). $3x + 1 = 12q + 1 = 5z$, which has integer solutions for q = 2, 7, 12, 17, . . . This provides a set of solutions for $a^3 + b^4 = c^5$.

For $q = 2$, $x = 4q = 8$, $y = 3q = 6$, $z = \dfrac{12q + 1}{5} = 5$

$a = 2^x = 256$, $b = 2^y = 64$, $c = 2^z = 32$.
Also solved by Ronald Raines, Judith Longyear, Richard Hess, Harry Zaremba, Leo Harten, Irving Hopkins, Ruben Cohen, Anthony Beris, Sidney Shapiro, Dick Boyd, Charles Sutton, David Evans, and Robert Slater.

Better Late Than Never

NS 10 B. Laporte has some further partial results.
1981 OCT 4 Matthew Fountain found an exact solution:

$$\frac{\sqrt{2}}{4} - \frac{4}{3}\pi - \frac{5}{2}\cos^{-1}\left(\frac{\sqrt{6}}{3}\right) + 4\cos^{-1}\left(\frac{7}{9}\right)$$

This agrees to seven digits with Harry Zaremba's approximate solution. Copies of Mr. Fountain's derivation can be obtained from the editor.

1982 OCT 2. Matthew Fountain and an anonymous computer found the missing solution:

E I G H T	8 4 5 0 2
E I G H T	8 4 5 0 2
S E V E N	6 8 3 8 7
S E V E N	6 8 3 8 7
S E V E N	6 8 3 8 7
E L E V E N	8 1 8 3 8 7
T W E L V E × 4	2 9 8 1 3 8 × 4

Proposers' Solutions to Speed Problems

SD1 None, as the barge had been overloaded by 33 percent and would already be on the bottom.

SD2 Since East has eight clubs, there's a good chance of only two hearts in the East hand. Cash the ♠A and ♠K; if East follows he can have only two hearts originally. Cash the ♥A and throw West in with the last heart, for an end-play in diamonds. If East has only two spades, hope that West has the high heart honor after the ♥A. This was hand 28 from a tournament at Cherry Hill, N.J., on August 21, 1982. The end position was:

Dummy:
♠A K
♥A 7
♦A Q

West:
♠7 4
♥Q 10
♦K 7

East:
♠9 6
♥J
♦Q J 10

After the ♠A and ♠K and ♥A, West is end-played in hearts. He has to lead a diamond back at trick 12. Some declarers found this line of play; unfortunately, my partner wasn't one of them!

Code-named "Looking Glass," a fleet of sophisticated and hardened jets serves as SAC's secondary command post. One of the planes is airborne at all times, linked electronically to other command centers and to missile bases and strategic bombers.

graphical coverage.) Because the current generation of DSCS-II satellites are vulnerable to EMP and TREE effects, the air force is replacing them with new DSCS-IIIs. These have more capacity and more powerful transmitters, and are resistant to nuclear effects and jamming. Properly spaced in stationary orbit, the DSCS-III satellites will provide nearly global communications coverage.

In the late 1980s, the Pentagon will use the space shuttle to deploy an entirely new network of military satellites that will theoretically be capable of operating throughout a protracted nuclear war. The Military Strategic, Tactical and Relay (MILSTAR) network will most likely consist of three satellites circling in polar orbit, four in stationary orbit above the equator, and a number of spares. The satellites will be equipped with electronic sensors to detect threats such as antisatellite weapons, and will have small rocket motors that will enable them to take evasive maneuvers.

The MILSTAR satellites will have more physical hardening, better shielding against EMP and TREE (by means of radiation-resistant materials and paints and more robust microelectronic circuits), and a higher data-transmission capacity than existing military satellites. MILSTAR satellites will transmit messages using extremely-high-frequency (EHF) channels that are difficult to jam. EHF beams are also relatively narrow, making them harder to intercept. To provide redundancy, satellite terminals for MILSTAR will be installed in surface ships, strategic bombers and other C^3I aircraft, ICBM launch-control capsules, and mobile ground vehicles such as huge 18-wheel trucks.

Protecting Command Centers

If C^3I is akin to a giant nervous system, command centers are its ganglia, receiving intelligence information and transmitting commands to the far-flung forces. Within the continental United States, the command centers that direct the strategic forces include the National Military Command Center at the Pentagon (and an alternate underground version in Fort Ritchie, Md.), NORAD near Colorado Springs, and the underground SAC headquarters near Omaha, Neb. In addition, overseas command posts control tactical and intermediate-range nuclear weapons stationed with U.S. forces in Europe and in the Pacific.

Only some of these command centers are hardened, and as missile accuracy improves, there is virtually no way to guarantee their survival. Even NORAD headquarters—a complex of steel buildings buried 1,400 feet inside the granite Cheyenne Mountain on the edge of the Rockies—could not survive a direct hit with a 25-megaton warhead. Therefore, there is a backup system of airborne command posts—windowless Boeing 747s and 707s crammed with computers and communications equipment and hardened against EMP and nuclear radiation. One of these aircraft, known as the National Emergency Airborne Command Post (NEACP, pronounced "kneecap"), is usually on ground alert at Andrews Air Force Base ten miles from the White House. In a nuclear attack, the president (or vice-president) would be helicoptered to the NEACP and theoretically be safely airborne by the time Washington was destroyed.

These sophisticated airplanes also serve as the SAC Secondary Command Post (code-named Looking Glass), under the control of SAC's commander-in-chief. The Looking Glass planes have multiple redundant communications systems and the capability to launch any or all of the 1,000 Minuteman ICBMs. Looking Glass can launch the missiles directly or indirectly by sending the message via the airborne launch-control system (ALCS) aircraft that during a crisis fly over the three main ICBM fields. The ALCS planes can fire the missiles if the underground launch-control capsules have been destroyed. One of the Looking Glass planes is airborne at all times, taking an unpredictable flight path over the Midwest for eight hours at a time and not landing until another has left Omaha with a SAC general aboard who has taken charge of the system. In this way, SAC plans never to be caught by surprise.

Looking Glass is linked to the other command centers (including NEACP in a crisis) and the strategic forces not only electronically but also by means of communications-relay planes, which are collectively termed the Post-Attack Command and Control System. At least one of these planes is in the air at all times, with two squadrons on ground alert. They are equipped with radio transmitters using VLF and super-high-frequency (SHF) signals, both of which are relatively insensitive to the atmospheric disturbances caused by nuclear explosions. (VLF is transmitted by means of extremely long antennas that trail behind the aircraft.)

If all of these SAC relay aircraft are destroyed or

C^{3}I facilities would be priority targets in a nuclear war because they are "force multipliers" that make weapons more effective.

stop working, there is a final backup system that would release nuclear weapons for a massive retaliatory strike. Known as the Emergency Rocket Communications System (ERCS), it consists of a dozen Minuteman-3 ICBMs, stationed at the Whiteman Air Force Base in Missouri, equipped with tape recorders and UHF transmitters in their nose-cones. Looking Glass can broadcast the go-code to the ERCS missiles, which would then be launched and transmit the code to the ICBM force and the strategic bombers for about half an hour. Ironically, because the missiles are located with the land-based ICBM force and hence are theoretically vulnerable to attack, their ability to survive protracted nuclear exchanges is uncertain. Moreover, since ERCS is a last-resort system, it would probably be needed only during a large-scale attack rather than a more limited exchange.

Although the airborne command posts are clearly better able to survive than their land-based counterparts, they could probably not persist for more than a few days during a nuclear war. Nuclear ground bursts would inject large amounts of radioactive dust and debris into the atmosphere that could foul the jets' engines. And all airborne command posts must land eventually for maintenance and oil changes and to allow the crew to rest. With aerial refueling and an oil-replenishment system, the planes can stay airborne for three days. If a nuclear war were to remain limited, the planes could probably land at a number of airfields, but servicing, refueling, and getting them back into the air before they could be detected and bombed might prove extremely difficult. Indeed, as satellite surveillance technology improves, the Soviets might be able to track the airborne command posts in flight and destroy them even before they land.

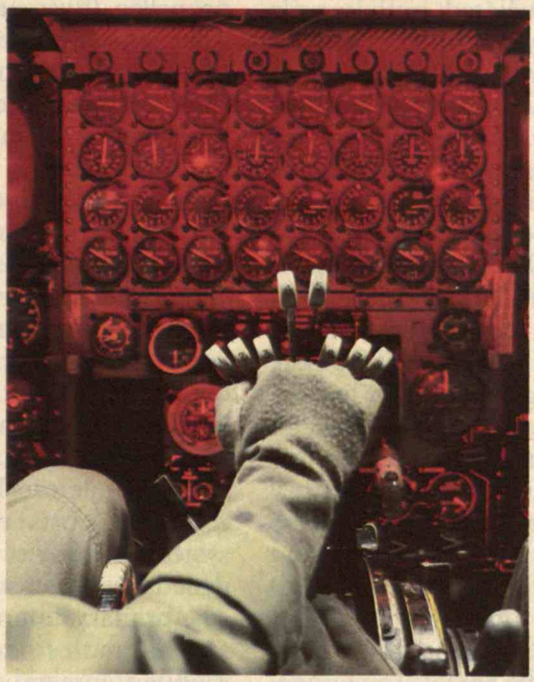
Communication with Missile Submarines

The missile submarines are the most survivable leg of the strategic triad, yet communicating with them is problematic even in peacetime. Submarines on full alert must maintain constant communication with the national command authorities. (Submarines on modified alert must make only periodic contact.) Routine communications are maintained by a system of redundant transmitting stations located around the world, which use frequencies ranging from very low to high. Since these radio waves cannot penetrate deep water, the submarines must slow down, come relatively close to the surface, and deploy a small antenna to receive signals. But this makes them easier to detect. To overcome this problem, the navy is developing an extremely-low-frequency (ELF) transmitter, which will be built underground in northern Michigan. ELF signals can penetrate seawater, enabling submerged submarines to maintain continuous communications with national command authorities while cruising at greater depth and speed.

Since all shore-based transmitters are vulnerable to attack or jamming, the navy also has a backup airborne system for emergency communications. Known as Tacamo ("take charge and move out"), this system consists of 18 modified EC-130Q turboprops with VLF transmitters. At least two of these planes are always flying over the Atlantic and Pacific Oceans. The Tacamos land randomly at a series of ground bases to make sure their locations cannot be easily targeted.

By the mid-1980s, the navy plans to begin replacing the current Tacamos with EC-X aircraft—Boeing 707 jets that will be larger and faster. Even so, the Tacamo system will remain vulnerable. The planes could be shot down by long-range Soviet interceptors, although a single plane might be difficult to track in the vastness of the ocean. More serious, the Tacamos can communicate with the national command authorities through only 14 ground radio stations that are vulnerable to attack. By the late 1980s, the navy plans to equip the Tacamos with terminals to communicate via satellite—including MILSTAR—but satellites may themselves be vulnerable.

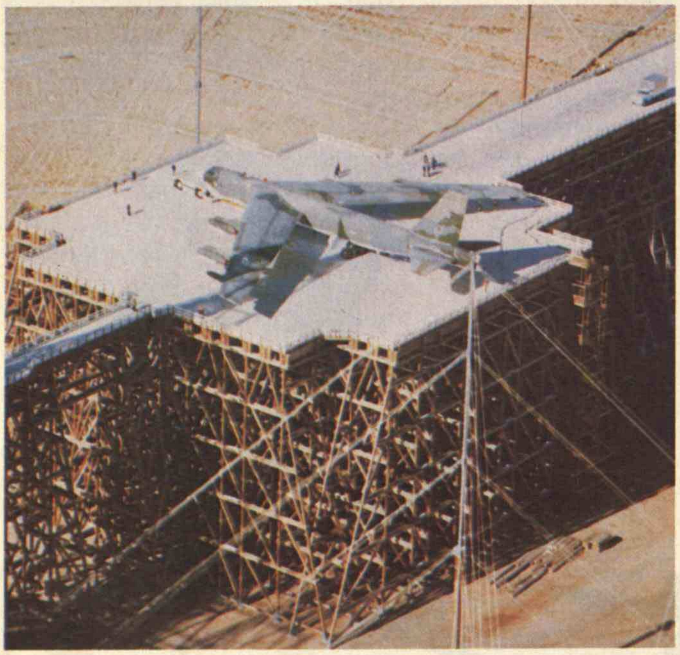
A still more intractable constraint is endurance. The Tacamos can fly for only ten hours at a time, which is long enough to order a prompt retaliatory strike but might preclude communications with submarines during a protracted nuclear war. To avoid having to communicate via the Tacamos, the navy is developing satellite systems that could provide direct communications with submerged submarines. One such approach, known as the Optical Ranging, Identification, and Communications System (ORICS), employs a laser of blue-green light, which is optimal for penetrating seawater. The lasers might be used in several ways. For example, one system calls for a large mirror in stationary orbit. A land-based laser would aim its signal at the mirror, which would reflect the beam back down to the submarine. In another scheme, the laser itself would be aboard a satellite. (Such laser systems could also be used in antisubmarine warfare.)

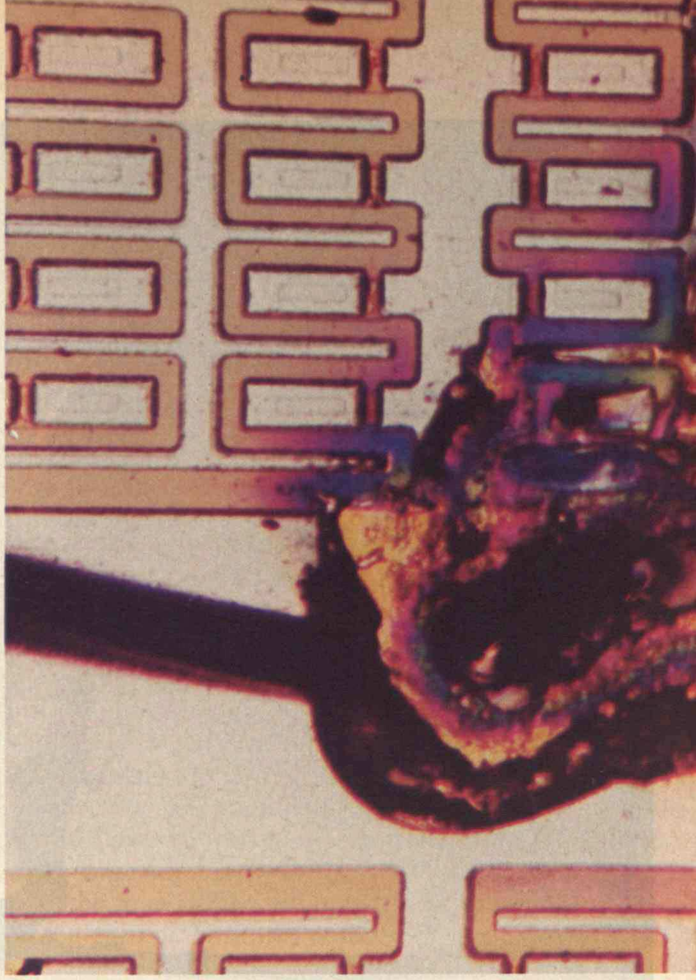


The primary purpose of the command-and-control system during peacetime is to maintain "positive control" over all nuclear weapons to prevent accidental use. At the earliest warning of possible attack, B-52 crews scramble into the air and fly a set distance toward their target, but must then wait for the "go-code." (See B-52 cockpit at left.)

Crews at Minuteman missile launch facilities (left) also follow detailed fail-safe procedures. Once the go-code has been received and authenticated, the "two-man rule" comes into play. Two individuals sitting at widely spaced consoles must simultaneously turn their keys to launch the missiles.

PHOTOS: STRATEGIC AIR COMMAND; HERMAN KOKOJAN, BLACK STAR



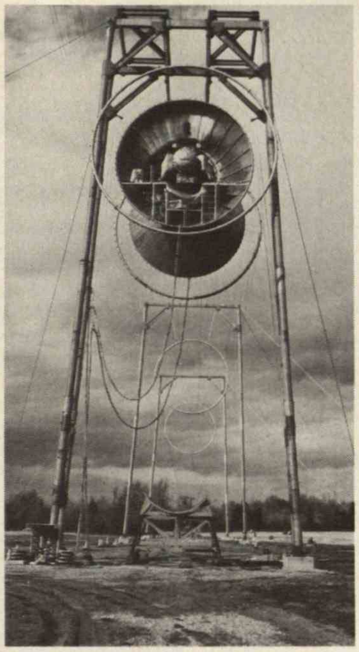


Beyond the fragility of communications links, there are other C³I constraints associated with missile submarines. The great accuracy of the new generation of submarine-launched Trident I missiles will depend on a network of 21 navigation satellites, the Navstar Global Positioning System, which will be fully operational by 1987. Navstar will provide the submarines with extremely precise information about their targets—pinpointing a Soviet missile silo to within about 30 feet, for example—so that a missile's trajectory can be calculated continuously by the sub's computers as it travels. Because the Navstar satellites might be vulnerable to antisatellite weapons or EMP, however, there would be strong pressure to use the Trident missiles in a nuclear war before the satellites were knocked out. Thus, although the submarine-based missiles are largely invulnerable to attack, they might be launched hastily rather than held in reserve for controlled escalation.

The Soviet C³I System

Like its American counterpart, the Soviet strategic arsenal is three-pronged, although the relative proportions are different: 1,398 intercontinental ballistic missiles, 145 strategic bombers (including 100 aging, propeller-driven aircraft), and 62 missile submarines. The Soviets' penchant for central control of their forces is one reason why they have devoted more of their resources to land-based missiles instead of bombers or submarines, even though the latter are less vulnerable to attack. Soviet missile submarines also spend less time at sea than their U.S. counterparts. Whereas the U.S. Navy maintains about 24 missile submarines on patrol, only 10 to 12 Soviet subs are usually away from port at any one time.

Little unclassified information is available on the Soviet C³I system, although it seems to be similar in overall structure to the U.S. system. For example, the PVO Strany command center serves the same early-warning function as NORAD. The major difference is that while the United States emphasizes airborne command posts as the "survivable" core of its C³I system, the Soviet Union has built thousands of hardened bunkers for government and military leaders. The primary command centers are dispersed within a 50-mile radius of Moscow. They are backed up by mobile command posts on trains, and by a small fleet of airborne command posts that are less sophisticated than their American counterparts and cannot remain



High-altitude nuclear explosions generate a brief but destructive electromagnetic pulse (EMP). Communications systems are particularly sensitive to EMP because they are connected to electrical conductors such as cables, towers, and metallic aircraft. Defense planners fear that EMP could shut down the nation's power grid for hours or days.

Center: An integrated circuit (greatly magnified) destroyed by EMP. Such advanced microelectronics, though faster and more useful, are also more vulnerable to EMP than vacuum tubes. Far left: A B-52 being tested for EMP "hardness" on the "Trestle" at Kirtland Air Force Base. Left: A transportable EMP simulator is used to test electric power lines.

in the air for long periods. All the command posts are linked to the Soviet missile, bomber, and submarine forces through extensive networks of telephone lines, radio systems, and Molniya and other satellites, which now carry the majority of Soviet military communications.

The Vulnerable Chain of Command

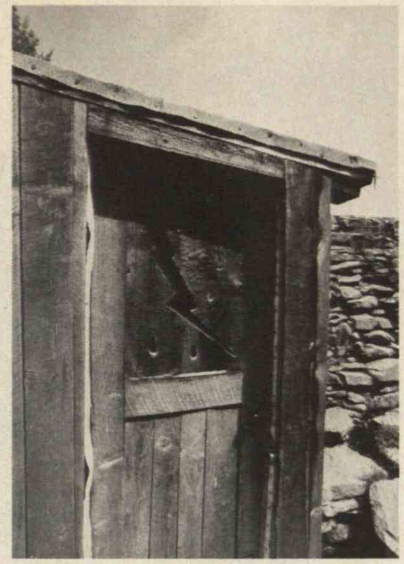
In the United States, the president is commander-in-chief of the armed forces and has the ultimate authority to order the use of nuclear weapons. Wherever the president goes, he is accompanied by communications gear and a military aide carrying a black briefcase known informally as the "football." This case reportedly contains the go-codes that would enable the president to order a retaliatory strike. According to the Reorganization Act of 1958, the president would give the command to the secretary of defense, who would in turn direct the chairman of the joint chiefs of staff to execute the attack. Thus, the president cannot authorize the use of nuclear weapons without the involvement of two other high officials.

The major unclassified strategy for ensuring that the national leaders survive a nuclear war is to get them aboard the NEACP airborne command post before Washington is destroyed. Although this plan might work in a slowly building crisis, there would not be sufficient time to reach the command post during a surprise attack. While evacuating the president to NEACP by helicopter would take at least 20 minutes, a Soviet submarine off the East Coast of the United States could fire a missile in a low-altitude flight path that would strike the White House within five minutes. And 20 minutes for evacuation might be overly optimistic. In a surprise test of the system in 1977, 45 minutes elapsed before the first helicopter arrived at the White House, and then it was reportedly almost shot down by Secret Service agents.

If the president were killed, his authority would automatically pass down the line of 16 constitutionally designated successors, beginning with the vice-president, speaker of the house, president pro tem of the senate, and members of the Cabinet. In fact, the Reagan administration has proposed a central locator system, devised by the Federal Emergency Management Agency, that would keep track of every possible successor. But in the confusion and horror following

Continued on page 74

PHOTOS: U.S. AIR FORCE; U.S. ARMY; DEFENSE NUCLEAR AGENCY



How Small Hydro Is Growing Big

New technology, new incentives, and the New England tradition of independence are coming together to spawn new sources of electricity in the hills and rills of the Northeast.

BY WILLIAM A. LOEB

NEW England's textile mills are gone—and with them the water power that started it all. But as you wander the hills and streams you'll still find signs of old dams, powerhouses, flumes, and machinery—small scale all. These sites sank into obscurity under the onslaught of cheap electric power generated in large fossil-fuel plants and distributed over a web of power lines. But small hydro sites are now rebounding as the cost of power climbs—and with it our interest in renewable energy. Typical of the range of small hydroelectric units now under redevelopment are those in Lawrence, Mass. (15,000 kilowatts), Bow, N.H. (7,000 kilowatts), Berlin, N.H. (3,000 kilowatts), Bernardston, Mass. (100 kilowatts), and Union, N.H. (30 kilowatts).

The intriguing question raised by all this action is, "Can I have a hydro plant on my stream?" People such as Dave Brown in Shutesbury, Mass., have answered "yes"; he has installed a 4-kilowatt generator in a dam forming his farm pond. Others with suitable "personal hydro" streams will follow as the economics and the technology become more favorable.

What's making these small units economically attractive again? In addition to rising energy costs, there are three things:

☐ The very electricity distribution grid that helped shut down small-scale hydro is now bringing it back to life. The Public Utilities Regulatory Policies Act of 1978 (PURPA) decreed that utilities must buy electric power fed into their lines from small, privately owned generators—and at rates equivalent to the utilities' savings from *not* generating that electricity themselves. This "avoided cost" is substantial, since it usually represents today's high price of fossil fuel (probably oil) burned at low efficiency. The rate utilities must pay for hydro power has been set at about 8 cents per kilowatt hour in New Hampshire, about 5 cents in Massachusetts, and 7 to 8 cents in Vermont. Thus, the owners of a small hydroelectric unit have a guaranteed market at a good price for any surplus power they generate.

The only long-term market risk is that avoided-power costs might fall as utilities replace older plants with efficient new units, or as oil prices decrease in slow economic

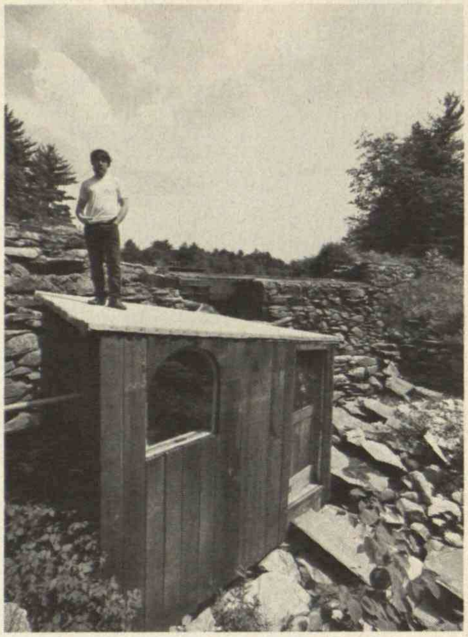
Fully exploited like these at Bernardston (opposite) and Shutesbury, Mass., 6,500 sites for small-scale hydro-power generation in New England could add 500,000 kilowatts of fuelless electricity to the region's generating capacity.

PHOTOGRAPHS BY FRANK SITEMAN

Small-scale hydro could add 7 percent to New England's present electric capacity—no fuel required.

times. The other side of that coin is that PURPA rates may rise with fossil-fuel costs. Despite the current sagging oil prices, hydro owners are betting on the latter; most are confident that too much oil above ground is not a reliable harbinger of too much oil below ground.

□ Environmental concerns and the high cost of land now make acquiring and developing the huge reservoirs needed for large hydro generating units very difficult. The problem of environmental impact statements was unknown in "the good old days" when the 100-year-old small power sites were first developed, and the environmental effects of these plants are now accepted as part of the status quo. This situation is reflected in large part in the public review process. The environmental impacts of new small units are also far less and far more easily evaluated than those of larger-scale plants, and this situation, too, is recognized in most regulations governing public review processes for small hydroelectric plants. Federal, state, and local regulations usually provide various short-cut licensing procedures and exemptions for new small-scale plants.



□ The theoretical hydro potential of many of New England's hilly, rainy areas is appreciably larger than the generating capacity of established hydro sites. Since few new larger sites can be developed, exploitation of much of this remaining potential will depend mainly on small units. How much of this potential is actually developed will depend on the general level of energy prices and on how much technical progress can reduce the costs of small units.

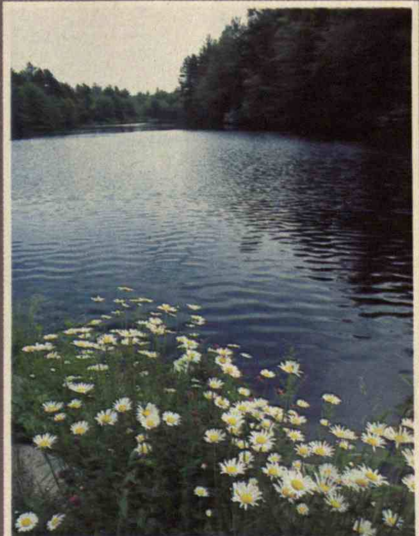
1.5 Million Kilowatts Waiting

The first question to be answered is what's already there—the dams and mills that lie forgotten among the New England hills and valleys. The New England River Basins Commission in 1980 (before its untimely demise) compiled an exhaustive list of some 8,200 such existing or former dam sites. Of these, 1,700 could produce over 50 kilowatts of electricity each; 300 are rated at over 2,000 kilowatts, with total capacity of 1 million kilowatts. The 6,500 sites under 50 kilowatts could yield a total of 500,000 kilowatts. Today's water flows are largely the same as they have been since colonial times. Man has made few modifications, and the total potential amounts to about 7 percent of New England's current generating capacity. If the dam and pond already exist and can be used without major refurbishing, the smallest economic unit is one producing less than 250 kilowatts. Naturally, if the price of electricity should increase, this size would be reduced.

New hydro plants are more expensive to build, costing as much as $3,000 per installed kilowatt. Under current conditions of cost, interest, and electricity, the smallest economically attractive all-new unit would be about 5,000 kilowatts in size. When the capital costs are reduced by a 21-percent federal tax credit, this minimum economic size is lowered to about 2,000 kilowatts. That figure may be further reduced by using a five-year amortization for tax purposes. These two benefits stem from other federal acts—the Crude Oil Windfall Profits Tax Act of 1980 (COWPTA) and the Economic Recovery Tax Act (ERTA).

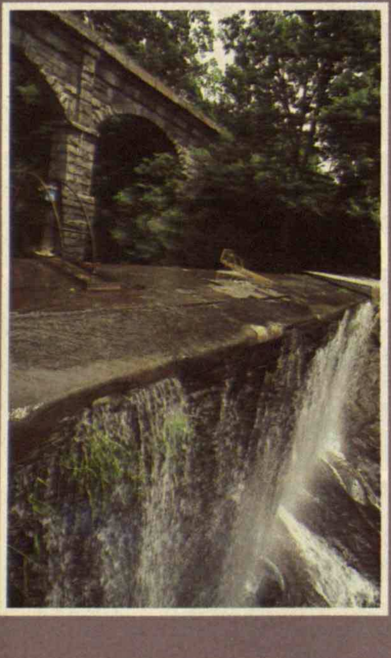
Once built, hydro units of whatever size have a long life, use no fuel, need minimal operating crews, and require very little maintenance. Annual operating and maintenance costs are usually only 4 percent of the initial capital investment. Thus, revenues from selling electricity go mostly to pay for the cost of capital.

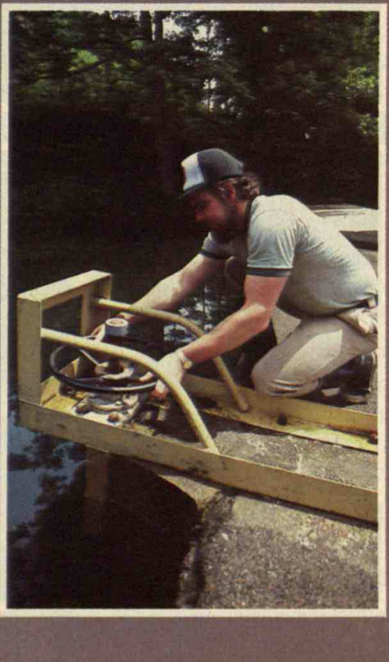
A hydro unit can generate power only when two conditions are met: water must be available, and there must be demand for electricity, since straightforward storage of large amounts of unused electricity is not practical. With the elements determining the waterflows and consumers setting the consumption pattern, hydro operators in the past had to store water in ponds until needed. But today's operators have a major advantage: PURPA assures owners of small hydro plants that they can supply their electricity to today's large electric transmission



Farmer Dave Brown of Shutesbury, Mass. (shown on his generator house, opposite page), has achieved the ultimate in energy independence: a hydroelectric plant of his own. At a cost of $5,200 and some personal labor, Brown added a small penstock and a 4-kilowatt generator (lower left) below his farm pond (above). His electric bill (below) tells the story: in a full year of operation, Brown sold surplus power to the grid in all but two months, avoiding the need to purchase 7,500 kilowatt-hours of electricity that used to cost about $700. The large photograph shows the complete system from below—dam and spillway, generator house, and sluice through which spent water rushes to rejoin the stream.

Steve Atwill (lower right) will capture up to 80 kilowatts of energy now unused at his Bernardston (Mass.) Grain Mill by placing generators in the overflow ports of his 130-year-old dam (page 50). He'll continue to use the mechanical turbine (below) for grinding grain, and when water supplies permit he will sell fuel-free electricity to the Western Massachusetts Electric Co.





To a small hydro owner, the power grid is like a battery: it will take electricity when surplus and give it back when needed.

grids—and draw it back again—at the hydro operators' convenience. No longer must operators fear a summer dry spell. The grid will supply what the pond cannot. In effect, a small producer has a "battery" that will take electricity whenever it is fed in and will return electricity whenever the producer wants it back. Whenever it receives some hydro-generated power, the electric grid simply saves some fossil-generated electricity. Thus, the need for pond storage is much reduced. Since a water-storage area may well amount to as much as 25 to 50 percent of a small plant's capital cost, this advantage gives small hydro another nudge up the ladder of economic feasibility.

Commercial-Scale Small Hydro: Simple Economics

Today's activity in plants of more than 5,000 kilowatts of capacity is largely due to rising electricity prices combined with people's natural desire to acquire local, uninterruptible energy sources. Over 23 such sizable projects totaling over 400,000 kilowatts are in various stages of licensing and funding in New England, some partially supported by federal or state funds. This is half of the New England River Basins Commission's total estimated capacity in this size range.

The Lawrence, Mass., project is typical of these larger units. In operation since 1981, the plant generates 15,000 kilowatts using the Great Stone Dam, 920 feet long and 30 feet high, across the Merrimack River. The electric output of the plant is sold to the New England Power Co. at its avoided cost, replacing about 160,000 barrels of oil a year. The dam was originally completed in 1848 and supplied power for the mills that made Lawrence a major textile center. Rehabilitation and new generating equipment cost $29.5 million, about $5 million of which was supplied by equity investors and $24.5 million loaned by an investor/insurance-company consortium; no government funds are involved. Plant operators have reached an agreement with the city of Lawrence to pay about $300,000 a year in lieu of taxes. Had this arrangement not been made, the city might one day have assessed not only the current investment but also the value newly added to the existing dam and water rights. The possible increase in property taxes would have made the project unattractive to investors.

At Garvin Falls, on the Merrimack River near Bow, N.H., the Public Service Co. of New Hampshire has revamped a portion of an existing hydro plant. The 30-foot-high dam remains unchanged, but a new powerhouse with two new turbines has been built. Output is 7,200 kilowatts with a capital cost approaching $9 million ($1,250 per kilowatt), of which the Department of Energy granted $1 million. Power costs are 3 to 4 cents per kilowatt-hour.

How to Test Your Site

How can a property owner judge the hydro-power potential of the stream flowing down his or her hillside? Making a first-order approximation is simple. The average output of the site in kilowatts equals the flow of water, measured in cubic feet per second, multiplied by the number of feet the water falls, divided by 15 (a constant appropriate for most sites.)

Expressed in a formula, it looks like this:

$KW = (CFS \times H) \div 15.$

Accordingly, for farmer Dave Brown in Shutesbury, Mass., to generate 4 kilowatts of electricity from his 15-foot drop, or "head," he needs a flow of 4 cubic feet of water per second. For the Bernardston Grain Mill to cover its needs of 25 to 80 kilowatts with its 20-foot head requires a flow of between 19 and 60 cubic feet per second.

Anyone can test a site's promise by applying this formula. To estimate flow, drop a wood chip or a leaf on the water in your stream and measure how many feet it travels in a second. This velocity in feet per second, multiplied by the width of the stream and its depth, will give you a measure of flow (in cubic feet per second). Another means of estimating expected flow is to use a U.S. Geological Survey topographic map to measure the drainage area above your site. In New England, each square mile of watershed is likely to supply an average of about 1.5 cubic feet per second of flow during the year. This allows a good cross-check on your dam-site measurement.

If this preliminary result is encouraging, the owner should obtain professional help in making careful measurements and estimating economic performance of a personal hydro plant.—*William Loeb* □

Smaller Hydro: Where the Action Is

The economics of smaller units depend primarily on various forms of special financial encouragement.

A Catalog of Government Incentives for Small-Scale Hydro Development

FEDERAL

Department of Energy:

* Small hydro loans	Pay 90 percent of the cost of a feasibility study; loan forgiven if the result is negative.
* Demonstration grants	Up to 15 to 20 percent of total capital requirements for 20 small-hydro projects; five in New England.
* Energy development projects	Support for 16 projects, with emphasis on small units.

Public Utilities Regulatory Policies Act of 1978 (PURPA)
Utilities required to purchase electricity at the "avoided cost" of generation and to sell electricity to generators, when requested, at regular rates.

Crude Oil Windfall Profits Tax Act of 1980 (COWPTA)
For small units utilizing existing dams (up to 25,000 kilowatts), 21 percent tax credit on capital investments; a lesser percentage for larger units to 125,000 kilowatts.

Alternatively, small-scale hydro investors may qualify to issue tax-free industrial revenue bonds.

Energy Regulatory Commission:
Small-scale hydro units of under 5,000 kilowatts are exempt from licensing requirements; short-form procedures are available on units between 5,000 and 80,000 kilowatts.

Economic Recovery Tax Act (ERTA)
Five-year amortization of capital investments in new equipment and dam reconstruction and repair (excludes half the COWPTA tax credit taken above).

NEW ENGLAND STATES

° Exemption of hydro developments from residential and corporate property taxes.

° Resident and corporate income tax credits for small-scale hydro investors (except Massachusetts, which offers income tax reductions).

* Loans to small-scale hydro developers at reduced interest (except Massachusetts, which offers outright grants).

Establish rates at which utilities must purchase hydro-generated electricity under PURPA (8 cents per kilowatt-hour in New Hampshire, 7 to 8 cents in Vermont, 5 cents in Massachusetts).

Powerplant siting requirements simplified for small-scale hydro plants.

Environmental requirements reduced for small-scale hydro developments.

* No longer in effect.

° Subject to legislative review and renewal in most states between 1983 and 1985.

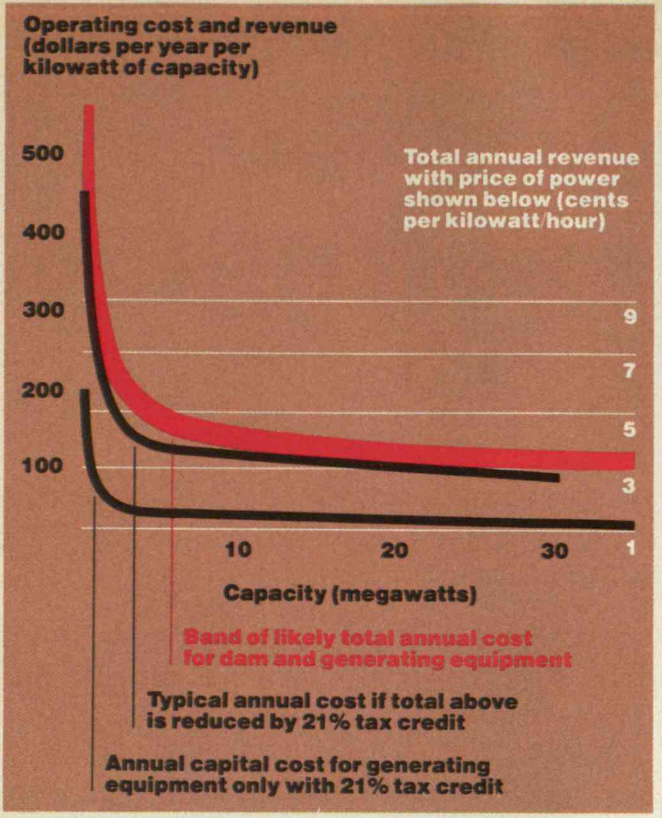
The Department of Energy's development and grant programs have helped to bring small hydro back into the limelight. Though these are now ended, a number of incentives remain at both state and federal levels (*see above*). The real encouragement for most owners of small units has been two-fold: the assurance that surplus power could be sold and the tax advantages that help offset the high initial capital investment. These key incentives are embedded in federal law and unlikely to be terminated. Indeed, the PURPA provisions requiring the connection and sale of electricity from private owners to existing public utility grids have survived several court challenges and this spring were unanimously found constitutional by the Supreme Court. The legal foundations of small hydroelectric generation are now solidly in place.

These government incentives have stimulated a large number of small projects that will seed a growing interest in oil-free electric plants. In New England there are 11 projects in the 2,000-to-5,000-kilowatt range and over 40 projects of under 2,000 kilowatts—a total of nearly 100,000 kilowatts of capacity. Since the New England River Basins Commission study shows a total potential of 500,000 kilowatts in sites of less than 5,000 kilowatts, there is considerable room for more plants. If half the commission's sites were developed, oil consumption would be reduced by 7 million barrels a year. This goal may seem ambitious, but is still possible. For example, in Massachusetts alone, the state's newly formed Energy Facilities Siting Council is receiving applications for hydro sites at the rate of about one a month.

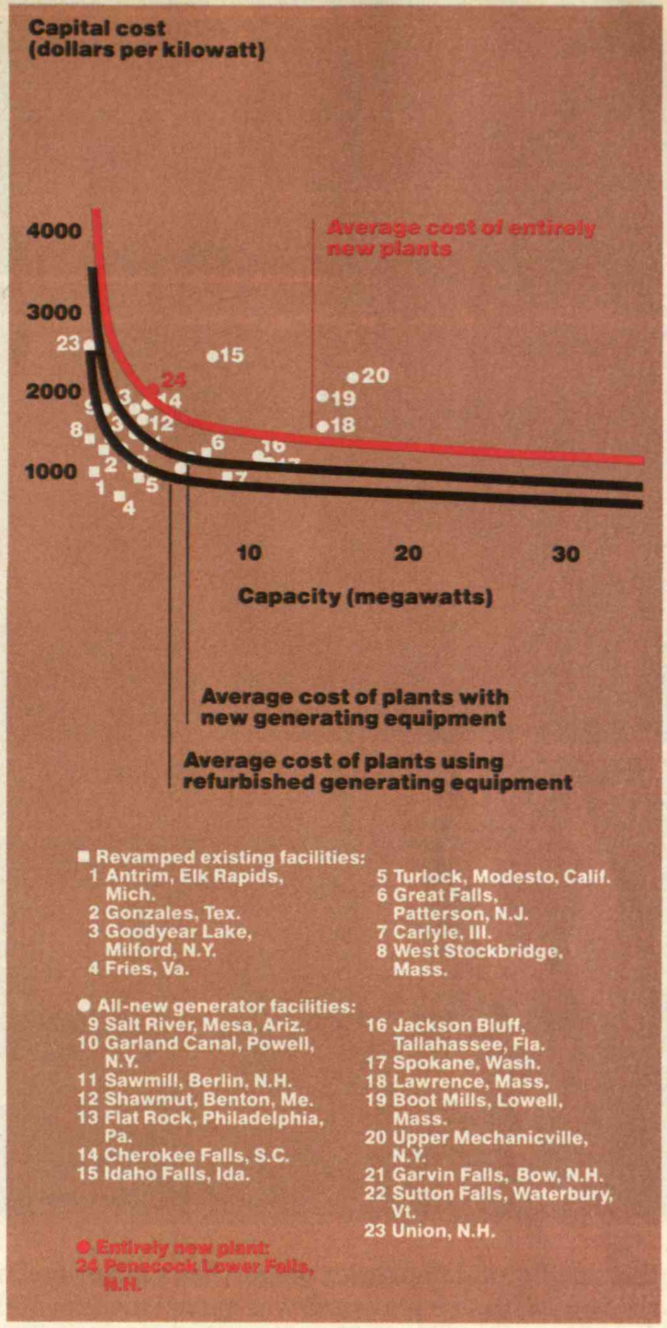
Here are some examples of current activities.

On the Androscoggin River in Berlin, N.H., a hydro plant was shut down in 1960 when the James River Corp., manufacturers of paper, found it cheaper to buy caustic soda than to make the chemical. Now the plant has been refitted—the so-called Sawmill Hydro Project—with four new turbine-generators using the existing 17-foot dam and powerhouse structure.

Full output is 3,200 kilowatts. The capital cost of



With today's incentives, small-scale hydro can be a good investment. The chart shows the typical cost to generate electricity in plants of various sizes built with and without the advantage of existing dams. Also shown is the effect of the 21-percent investment tax credit available under the Crude Oil Windfall Profits Tax Act of 1980. The white lines show the likely income from selling the electricity at different prices. Where the curves intersect them, income equals cost—indicating the smallest money-making unit for a particular energy price.

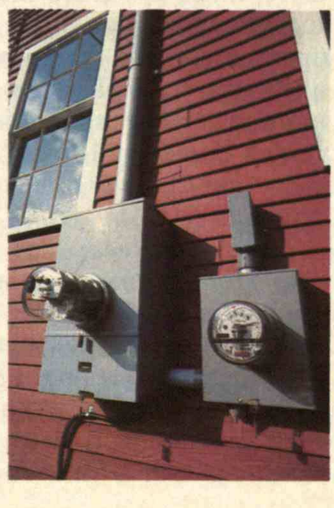


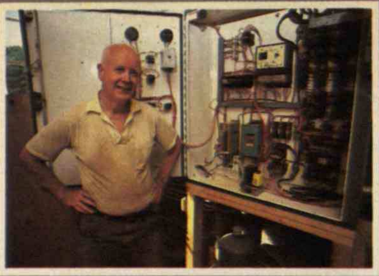
$4.6 million amounts to $1,450 per kilowatt of capacity. Since year-round water flow is steady, the plant can operate at near capacity most of the time. Economic breakeven occurs with the price of power at about 4 cents per kilowatt-hour.

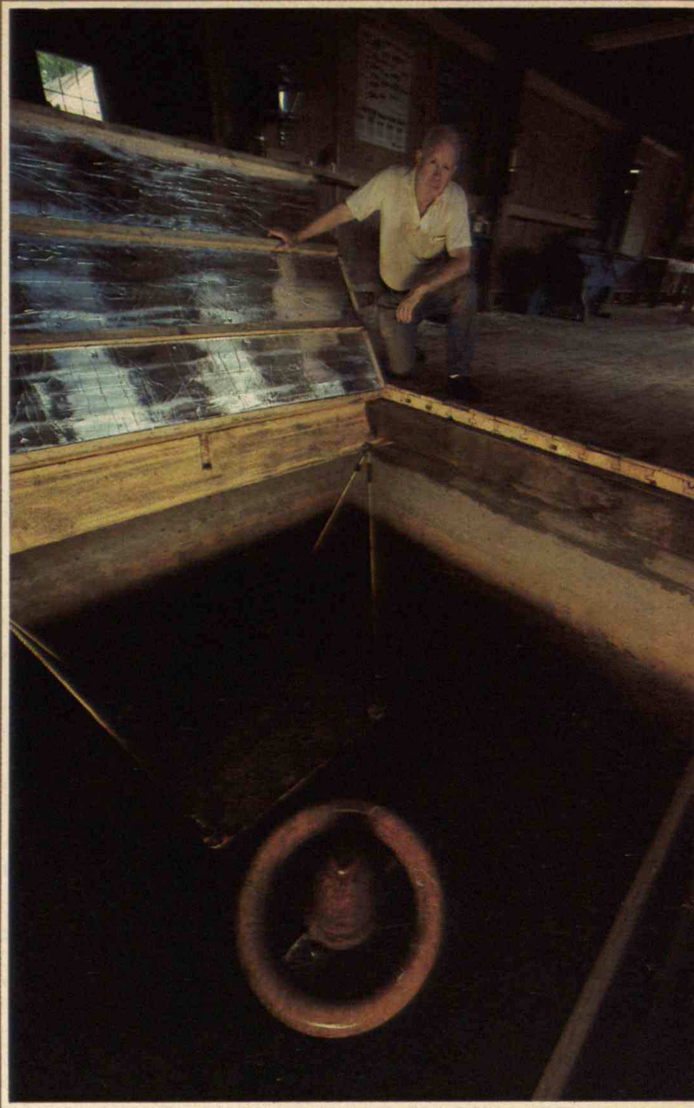
Interestingly, the decision by the James River Corp. to refurbish the plant hinged not on this cost of power, which was clearly going to be below the cost of purchased electricity. The real problem for the hydro project was that the return on capital invested in hydro was less than that available from paper-making projects. With limited capital available, the higher-return projects kept getting the nod. To overcome this constraint and put a good-sized hydro plant into operation, the Department of Energy provided a grant of $1 million.

A good example of a smaller, privately held unit is the Bernardston Grain Mill in Bernardston, Mass., on the Fall River along the northern border of the state. The mill was established around 1850 using two mechanical-drive hydro turbines that took water from behind a 20-foot dam, and it has operated

The capital cost to build or refurbish small-scale hydro plants has ranged from about $750 to $2,500 per kilowatt of capacity. The figure depends heavily on the amount and "head" or drop of water available, as well as on the amount of construction required. (The capital cost of ultrasmall "personal hydro" units producing 3 to 5 kilowatts is obviously higher than this range—about $5,000 per kilowatt.)







To become a seller instead of a buyer of electricity, John Bowker two years ago refurbished a 9-foot dam in Union, N.H., and installed a submersible 30-kilowatt generator under the floor of the old mill building. To show the unit to our photographer, he turned off the maelstrom of water that normally cascades through the chute (right) into the turbine beneath the mill. Bowker estimates his total cost at $75,000 not counting tax credits, and he produces about $8,000 worth of electricity a year. His total investment will be returned in earnings by 1988.

through fire and flood ever since. After a major fire in the late 1880s, the grain mill was moved to a site 300 feet from the river, with an overhead rope-pulley drive, much like a ski lift, bringing power from the turbines. Only one of the old turbine units is still in operation. While the power from this turbine is adequate for the mill's present needs, clearly there is more water flow than this old unit can utilize. Flow studies based on 10-year records of nearby streams show that the river can support a generating capacity of about 80 kilowatts.

The dam already has three pipes through it—a seven-foot-diameter wood penstock feeding the mechanical-drive turbine, and two drainage pipes 18 and 30 inches in diameter. The plan is to put a 25-kilowatt generator on the smaller drainage pipe and a 55-kilowatt generator on the larger, both units to work in conjunction with the mill's existing turbine. When the mill is shut down at night and on weekends, the two new turbines will use all available water to make electricity for sale to Western Massachusetts Electric Co. During the day the new turbines will utilize whatever water is not needed to power the mill. When summer brings low water flow, the mechanical-drive turbine will run by itself.

Simplicity is the unifying theme of this arrangement. The dam has existed for over 130 years, the mechanical turbine has run the mill for over 100 years, and the pipe penetrations already exist. Rule one for hydro renovators: don't disturb any of this.

Rule two: develop the means to switch the generators on and off line as simply as possible. Here modern electronics makes two important contributions. One is a rugged and reliable "induction" generator, whose rotational speed adjusts automatically to the frequency of the power line it is to feed. The other is a "black box" of solid-state electronics that can start and stop the generator automatically.

Compared with farmer Dave Brown's 4-kilowatt home system, small-scale hydro can be large. In Berlin, N.H., James River Corp. is completing the 3,200-kilowatt Sawmill Hydro Project by equipping an existing powerhouse with new generators at a capital cost of $1,450 per kilowatt (left and top). An existing dam at Bow, N.H., is being equipped with new turbines (left, center) to generate 7,200 kilowatts for Public Service Co. of New Hampshire; the cost will be $1,250 per kilowatt. And an old dam on the Contoocook River is being rebuilt at Penacook, N.H. (left, bottom) to add 4,100 kilowatts of fuel-free electricity to the Public Service Co.'s grid.

Generator and power grid are now protected from each other's possible malfunctions. Even when rotating at speed, such a unit generates electricity only when it can meet the frequency requirements of the transmission grid. If the transmission line fails, the induction generator goes out of action.

Rule three: build as little as possible—no new pipes to carry water, no shelter buildings. For example, Bernardston Grain Mills' project is financially attractive because of the small expenditure required for civil works; all the investment will go for generating machinery. The generators will be submersible units mounted directly in the flow piping itself. The 25-and 55-kilowatt generators will produce revenue of $18,000 a year compared with the anticipated capital cost of $44,000 to $60,000, not including the owner's sweat equity. This cost represents only two to four years of revenue. And when the tax credits and 5-year amortization for tax purposes are taken into account, the net capital investment may be reduced by 20 to 30 percent, making the project even more attractive. (Many hydro projects are organized as tax-shelter partnerships for high-tax-bracket participants because of these tax credits and writeoffs.)

In Union, N.H., a privately owned 30-kilowatt unit has been running routinely since 1981, installed at the site of an old mill with an existing 9-foot-high dam. A small, submersible turbine-generator is located in a concrete flume, or chute, below the building floor. The unit operates totally automatically, coming on or off line as the water level behind the dam dictates. As with so many of today's "personal" energy projects in which the owners do portions of the work, the cost of the project is difficult to determine. The owner estimates that the capital cost at Union is $75,000. Revenue from the sale of electricity

Continued on page 69

The Case for Ocean Waste Disposal

BY WILLIAM LAHEY AND MICHAEL CONNOR

With America facing a crisis in land waste disposal, local goverments and businesses are turning to the sea. We need to develop a regulatory program that relies on economic incentives to curb potential health risks.

LOVE Canal, Times Beach, Valley of the Drums—these names are giving nightmares to every community confronted with the problem of waste disposal. Residents living near toxic waste sites are becoming increasingly alarmed about the potential health hazards, and the demand for "Superfund cleanups" is growing. In many states, local opposition to newly proposed disposal sites has sprouted overnight, and older sites continue to fill up and close down.

With America facing a crisis in the disposal of its wastes on land, more and more eyes are turning to the sea. Many businesses and municipalities see the ocean as a cheaper alternative to building landfills, advanced treatment plants, and incinerators. They also recognize that the sea has virtually no political constituency fighting to protect its health and environmental rights. As a result, a growing number of waste generators are seeking ways to dispose of their wastes at sea. Millions of tons of waste are already being dumped into the ocean each year, and federal guidelines have failed to effectively regulate such practices.

At the same time, recent studies of marine life around specific dumping sites show that the ocean is not as fragile as we once believed. There are many unanswered questions about the impact of waste disposal on our oceans—how much is safe and at what sites. But there's little doubt that the ocean, particularly its deep-water areas, has some capacity to assimilate both sewage and industrial wastes. Today, scientific forces as well as powerful economic and political ones are pushing us into a policy that permits the use of the sea as a major dumping site.

That doesn't mean we should subject our oceans to the 10 million tons of dry sewage sludge, 30 million tons of sludge from air purification processes, 300 million cubic yards of dredge spoil, 65 million tons of fly ash, and 100,000 cubic meters of low-level radioactive waste that America's disposers, according to recent EPA estimates, would like to dump there. If ocean waste disposal is not to become a disaster of similar (or worse) proportions to the problem of disposal on land, we must first evaluate the ocean's capacity to assimilate waste and then regulate its disposal accordingly. Major changes are needed in the way we now approach ocean waste disposal. Specifically, we must devise a policy that relies on economic incentives to limit environmental and health risks. One approach would be to charge a fee for ocean waste disposal according to the amount of wastes to be dumped and their level of toxicity.

Navy officials want to dump aging nuclear submarines at sea; they believe the sinking of these subs poses no danger to human health.

Protecting the Clear Blue Sea

But before we can discuss the future, it is important to put the past into perspective. In the late sixties and early seventies, the American public seemed determined to protect the ocean. The generally heightened awareness of environmental issues during this period was only one of the catalysts for concern over ocean dumping. Public ire had also been aroused by the dumping of a large amount of nerve gas into the ocean by the U.S. Army in 1970. In the same year, the President's Council on Environmental Quality (CEQ) released a report concluding that stringent legal measures, both nationally and internationally, were required to protect the ocean. The CEQ reasoned that uncertainty regarding the environmental effects of ocean dumping should inspire caution, and its report concluded that until proven harmless, the dumping of materials that appeared environmentally sensitive should be discontinued.

Congress took its cue from the public. On a single day in 1972, it passed into law three major marine-protection bills: the Marine Protection Research and Sanctuaries Act, the Marine Mammal Protection Act, and the Coastal Zone Management Act.

In 1972, Congress also sought to control piped discharge of wastes into local rivers and estuaries. It amended the Federal Water Pollution Control Act, making it unlawful to discharge a pollutant into water without a permit from the Environmental Protection Agency (EPA). The amendments set an ultimate goal of eliminating all discharge of pollutants into navigable waters by 1985. They also required many communities to build secondary sewage treatment plants by 1977. In contrast with primary treatment, which uses only mechanical means such as screens to remove suspended solids from wastewater, secondary treatment uses microorganisms to break down organic compounds in waste. The objective is to decompose these compounds sufficiently so that when the liquid effluent is released into the nation's waters, no further oxygen is required to complete the process of decomposition; depleted oxygen levels can depress fish growth and survival rates. To encourage communities to build expensive secondary treatment facilities, the federal government held out an alluring carrot: it would pay 75 percent of the construction costs and the rest was to come from state and local funds.

The nation's protective attitude toward the ocean was also mirrored in the EPA's efforts to regulate the dumping of industrial waste and sludge—the solid material left after sewage has been treated. For instance, EPA officials imposed a 1981 deadline for the termination of all ocean dumping of municipal sludge and industrial waste. The agency was successful in stopping the dumping activities of more than 100 small municipalities, but those dumpers accounted for only about 3 percent of the total municipal waste dumped in 1978. The EPA was more successful in its efforts to control the dumping of industrial waste. Between 1973 and 1980, the volume of industrial waste dumped in the ocean was cut by almost half—from 5 million tons to a little over 2.5 million tons. The EPA also took a strong stand against the dumping of low-level radioactive waste: no permits were issued for this type of disposal.

More Expensive by Land

Today, however, the public mood and the nation's regulatory climate are very different—as is the economic picture. Over the last 10 years, the costs of land-based disposal systems have soared for two primary reasons: the myriad environmental regulations and the diminishing availability of suitable sites. While many of these regulations are necessary to protect human health and the environment, they have made it difficult for some municipalities to convert to new disposal methods. New York State, for instance, has imposed a two-year moratorium on using sludge as an agricultural fertilizer out of concern that crops might absorb cadmium, a heavy metal, from the soil. A sewage district in Salem, Mass., recently spent $3 million to build an experimental incinerator facility to dispose of its sludge. But a test burn unexpectedly revealed that the resulting ash would be classified as hazardous waste under EPA regulations, and there are no hazardous-waste-disposal sites in Massachusetts. The city subsequently filed for and received a permit to discharge its waste into the ocean. The incinerator stands idle.

High energy costs have also made incineration a relatively expensive proposition. The recently required use of air-pollution-control technology has further increased the expense. Primarily because of high operating costs, nearly one-fifth of all sludge incinerators constructed since 1970 have ceased operation.

Furthermore, rising land costs as well as opposition from local residents are forcing many businesses and municipalities to transport their wastes to isolated

sites farther and farther away. The resulting rise in transportation costs has motivated many disposers to look for cheaper alternatives.

As prices for disposal of waste on land rise, the cost differential between land and ocean disposal grows. Representatives from Orange County, which encompasses Los Angeles, recently told a congressional committee that the cost of discharging the county's sewage (both effluent and sludge) into the ocean was one-fourth the cost of disposing it on land. Ocean disposal, they testified, costs between $13 and $21 dollars per ton, whereas landfilling would run about $82 to $92 per ton. Boston, which seeks to continue discharging its sewage into the ocean under a special EPA waiver, has estimated that ocean disposal costs between two and nine times less than other alternatives. New York City has estimated that the land-based alternatives for disposing of its sludge are about 10 times as expensive as its current practice of hauling the sludge 12 miles out to sea and dumping it.

The Path of Least Resistance

As mentioned, public opposition to land-based waste disposal also presents major obstacles. In the mid-1970s, for instance, Nassau County, Long Island, which has dumped its sludge into the ocean since 1963, was told by the EPA to stop dumping. The county then constructed a $14 million composting facility, only to be dissuaded from using it because of intense local opposition to spreading the resulting compost on land. Ironically, there has been no evidence suggesting that land spreading of composted sludge would contaminate groundwater. But Nassau County continues to dump its waste into the ocean, and county officials are considering using the multi-million-dollar composting facility as a parking garage.

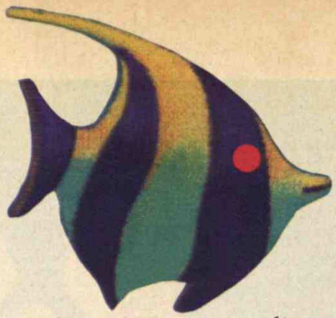
Some EPA regulations on ocean disposal have also been successfully challenged in court, preventing the agency from maintaining its strict policy of protecting the ocean. In 1980, for instance, a number of municipalities in California and Alaska sued the EPA, asserting that it was being overly restrictive in issuing waivers to the requirement that sewage be given secondary treatment. These municipalities argued that building and operating costly secondary treatment plants was unnecessary, since they could discharge their wastes into active ocean waters that rapidly assimilate and disperse it. The Washington D.C. Circuit Court agreed, in part, and directed the EPA to allow these and other municipalities to apply for permits to dispose by sea. Since the court decision in 1982, more than 200 municipalities have applied for such permits. The EPA is now in the process of reviewing the flood of applications.

The city of New York also mounted a successful court challenge of EPA regulations in 1981. City officials believed that the EPA had acted unreasonably because its 1981 deadline for terminating all ocean dumping had not taken into consideration the costs as well as the health and environmental risks of land-based alternatives. A federal district court agreed, ruling that EPA could not impose such a deadline without considering such factors.

In a highly unusual move, the EPA chose not to appeal the decision. Former EPA administrator Anne (Gorsuch) Burford said she wanted to let the ruling stand because it gave her agency needed flexibility. But U.S. Representative Norman D'Amours (D-N.H.) called her decision "a betrayal of congressional trust" and a "devastating blow to efforts to end harmful dumping practices." Having chosen not to appeal, the EPA is faced with the task of revising its now-obsolete regulations for ocean waste disposal. How they will be rewritten under the new administration of William Ruckelshaus, who was named to succeed Burford in May, remains to be seen.

Cuts in federal spending have also dampened the effort to protect the nation's waters. Under the Reagan administration, for instance, federal spending on the construction of sewage treatment facilities has declined by almost half—from $4.2 billion in 1979 to $2.4 billion in 1982.

Faced with mounting public opposition, increasing



costs, and a haphazard regulatory environment, America's businesses and cities are taking the path of least resistance. Cities such as Philadelphia, which had been forced to end its ocean dumping, have indicated an interest in returning to the sea. And other cities that have never dumped before are now exploring the possibility of applying for an ocean dumping permit. In the meantime, the number of tons of municipal and industrial waste already being dumped in the ocean is on the rise. More than 7 million tons of sludge, for instance, were dumped in 1982, compared with approximately 4.8 million tons in 1973. Researchers at the National Oceanographic and Atmospheric Administration (NOAA) have estimated that the amount of sewage sludge dumped could increase by nearly 150 percent (to 17 million tons) by 1987.

The amount of material dredged from the bottom of harbors and channels and dumped in the ocean is also increasing. Between 1977 and 1979, for instance, the amount of dredged material dumped nearly doubled—from 41 million cubic yards to approximately 73 million cubic yards. Morever, as deep channels are constructed to increase access to U.S. ports over the next few years, the amount of dredged material to dispose of will increase. The planned expansion of existing coal ports alone may require dredging and disposing of more than six times the amount dumped in 1979.

There has also been a surge of interest in dumping low-level radioactive wastes into the ocean. In January of 1982, the U.S. Navy announced it was considering dumping decommissioned nuclear submarines in the ocean. The navy says more than 100 aging nuclear submarines will have to be disposed of at a rate of 3 to 4 annually over 30 years. Meanwhile, the Department of Energy is interested in the ocean disposal of soil contaminated by radionuclides as a result of the Manhattan Project during World War II. Under Burford, the EPA said it was planning to revise its regulations to permit ocean dumping of low-level radioactive wastes. Afraid the EPA might be moving ahead too quickly, Congress enacted a two-year moratorium on such dumping. That deadline is up next spring.

The Effects on Marine Life

A number of recent scientific studies have been used to buttress the argument that the ocean should be used as a dumpsite. But on closer inspection, these studies confirm the need to approach the disposal of wastes at sea with a cautious and soundly developed management policy.

The most comprehensive series of studies on the impact of ocean dumping on marine life has focused on the coastal areas around Los Angeles and San Diego. For more than a decade, five municipalities and counties in Southern California have discharged their sewage effluent and sludge into coastal waters. In the last two to three years alone, an average of a billion gallons of sewage effluent a day has been discharged there. The studies were conducted by the Southern California Coastal Water Research Project (SCCWRP) and funded primarily by the five local governments who use the dumpsite. The scientists surveyed algae, fish, and plankton as well as species of worms, clams, and crustaceans that live on the ocean bottom in these areas, comparing them to marine life in areas with no known pollution.

The researchers found both positive and negative changes. While some organisms grew bigger and more abundantly near the areas of discharge, other species disappeared or suffered from a greater incidence of disease. For instance, the scientists found significant fin erosion among the flatfish that lie on the bottom near the piped discharge. They also noticed thinning in the shells of eggs laid by pelicans living on a nearby island and a resulting decline in their population; the scientists attributed these abnormalities to the discharge of DDT. More recently, the amount of DDT and other chlorinated hydrocarbons being discharged in municipal waste has declined owing to more stringent EPA regulations; the incidence of fin erosion and abnormalities in pelican eggs have declined as well.

In studying a major dump site on the East Coast, investigators also found evidence of significant degradation of marine life. The area they surveyed is located in the New York Bight apex in relatively shallow water (about 20 to 50 meters deep) 12 miles southeast of New York City. The investigators, who were affiliated with NOAA, the University of Rhode Island (URI), and the State University of New York at Stony Brook, found that animal communities living on the sea bottom were severely altered. As in Southern California, the flatfish suffered from fin erosion, and most fish species were contaminated with polychlorinated biphenyls (PCBs) and other highly toxic compounds. In response to these findings, the state of New Jersey recently issued a fish advisory suggesting that people not eat locally harvested fish

We should eliminate the need to dump highly toxic substances by developing substitute products and processes.

Contaminants	Effects of ocean disposal	Effects of land disposal	Effects of incineration
Pathogens (bacteria, viruses, and parasites)	Contamination of shellfish.	No problem if sludge is stabilized. Should not apply sludge on crops grown for raw consumption.	Destroyed by incineration.
Metals	Mostly non-toxic as a result of chemical changes after dumping.	Absorption of cadmium, zinc, nickel, and copper potentially toxic to plant growth. Potential hazard to human health from eating crops contaminated with cadmium.	Metals in air emissions and ash.
Organic chemicals	Bioconcentration by fish represents a potential health hazard.	Potential absorption by cattle grazing on land where sludge has been spread. Potential groundwater contamination by smaller, more soluble compounds.	Largely degraded by incineration. Possible formation of suspected carcinogens.

This table shows what happens to the contaminants in sewage and industrial waste disposed of by three different methods: ocean disposal, land disposal, and incineration. While metallic wastes can be most safely disposed of at sea, pathogens (in the form of treated sludge) can be more safely disposed of through land spreading or incineration. Incineration also seems to be the safest means of destroying organic compounds.

more than once a week.

As early as 1970, the Food and Drug Administration had banned shellfishing within 11 kilometers of the same dumpsite after finding evidence that shellfish were contaminated with coliform bacteria. These bacteria come from human excrement and often indicate the presence of agents of infectious disease. In the late seventies, other investigators found further evidence of coliform contamination. However, the New York Bight apex is polluted from a number of sources, so it is not clear what portion of these effects can be ascribed to the dumping of sludge.

Scientists at the Woods Hole Oceanographic Institution, URI, and NOAA also studied the impact of dumping industrial waste at a deep-water site much farther offshore. Here they found little evidence of degradation of marine life. Since the late sixties, manufacturers have used the site, located 106 miles east of New York City in waters about 2,000 meters deep, to dump wastes that contained sulphuric acid, ferrous sulphate, and small quantities of other metals. Because of the EPA crackdown and the recent recession, the amount of industrial wastes dumped dropped from about 2 million tons in 1973 to 800,000 tons in 1982.

Studying the site in the late seventies, the researchers found that increased concentrations of pollutants were temporary and confined to the immediate area of dumping. These concentrations were smaller than those found to be toxic in the laboratory, and the investigators were unable to conclusively attribute the changes they found in marine life to the material being dumped. The researchers think that the seeming absence of short-term effects is due to the dynamic currents of the ocean in deep-water areas. As Woods Hole biologist Judy Capuzzo notes, ocean waters at this site have a much greater capacity to dilute wastes because of the proximity to Gulf Stream currents and the depth of the water. Wastes are often diluted to almost a millionth of their original concentrations within a few days.

The problem is that most of today's ocean disposal is taking place in areas much less equipped to handle wastes—such as the Boston Harbor and New York Bight apex, which are shallow and less active sites. Most municipal and industrial dumpers are reluctant to discharge waste at deeper sites further offshore for one simple reason: cost. It's much cheaper to dump wastes a few miles offshore than to haul it hundreds of miles out to sea.

Obstacles to Change

Overall, these results indicate that the ocean has some capacity to assimilate waste—particularly active, deep-water areas fairly far from shore. But the question of how much waste it can assimilate and at what specific sites has not yet been answered. And these answers may be difficult to come by, not only because

We should be just as concerned about dumping PCBs in shallow ocean waters as we are about dumping them on land.

of political and economic obstacles but also because of some scientific stumbling blocks. The fact is that our thermometer for measuring the effects of waste disposal is not very finely calibrated. We have not yet developed the tools with which to predict the ocean's capacity for waste. We haven't decided, for instance, which organisms to study: "pollution-sensitive" species such as amphipods, crustaceans that are among the first to die in a polluted area; "ecologically important" species such as zooplankton that are essential to the marine food chain; or commercially harvested species. We also haven't determined which effects should be used to assess environmental impact: changes in a particular organism's enzyme system; changes in its ability to grow and reproduce, the death of an individual organism; or the death of its entire population. We also haven't decided which area should be used to calculate damage—the dumpsite boundary itself, the zone of initial dilution from a specific dump, or some larger, as yet undefined boundary.

Furthermore, many of the methods now used to test toxicity in the lab tell us little about toxicity in the ocean. In the lab, researchers usually test different concentrations of chemicals on a particular marine species, calculating safe levels through repeated experiments. But we can't conclusively link the results of these laboratory tests to actual effects on organisms in the ocean.

It is also difficult to separate the effects of waste disposal from other environmental perturbations caused by humans. For instance, the region around the New York Bight apex receives pollutants from river flows, atmospheric fallout, landfill leaching, and the dumping of dredge spoils, dirt, and sludge. It is hard for scientists to determine whether a decrease in a particular fish population is due to sludge dumping or to air emissions from automobiles and industry.

Some scientists believe that a threshold for safe levels of waste can be determined for ocean dumping much like the threshold that is used for waste disposal in freshwater. According to that standard, fish can survive only in waters where the dissolved oxygen content is above 6 parts per million; disposers are prohibited from discharging wastes that will lower the oxygen content below that level. While this particular threshold has been effective in areas where simple organic wastes are discharged, much of today's sewage contains a variety of industrial contaminants. Consequently, a number of different thresholds will probably be required to accurately predict the level of danger to marine life.

Furthermore, developing thresholds for ocean dumping depends on how we define unacceptable consequences. For example, a coastal area will be able to assimilate more waste if we define our threshold as undesirable effects on commercially harvested species rather than undesirable effects on the marine ecology. And if we decide to concern ourselves only with edible fish, then we must determine what kind of change we consider unacceptable: the reduction, say, in a particular fish population of 1 percent, 10 percent, or 50 percent.

The Risks by Land versus Sea

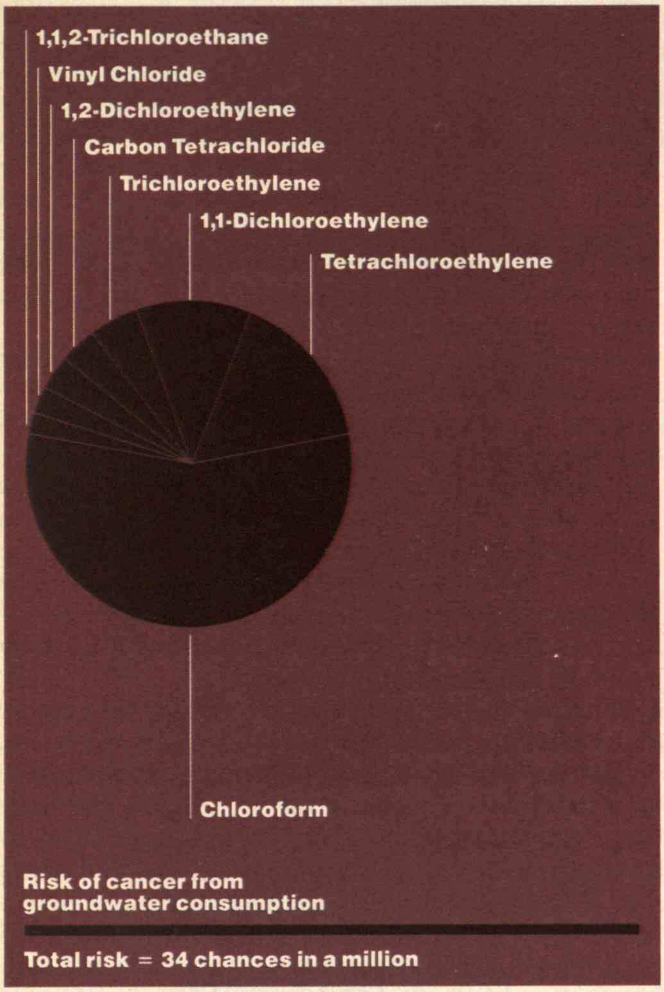
In recent years, many scientists, politicians, and industry representatives have suggested we are being overly protective of our oceans at the expense of our groundwaters. In two separate reports, one released by the National Advisory Committee on Oceans and Atmosphere (NACOA), a presidential committee, and the other by the National Academy of Sciences (NAS), authorities have voiced the concern that our stringent policy of protecting the ocean is only increasing the danger to public health by forcing the disposal of all wastes on land. Some NACOA and NAS scientists expressed particular concern over the contamination of groundwater from the leakage of PCBs and other hazardous compounds dumped in lagoons and landfills.

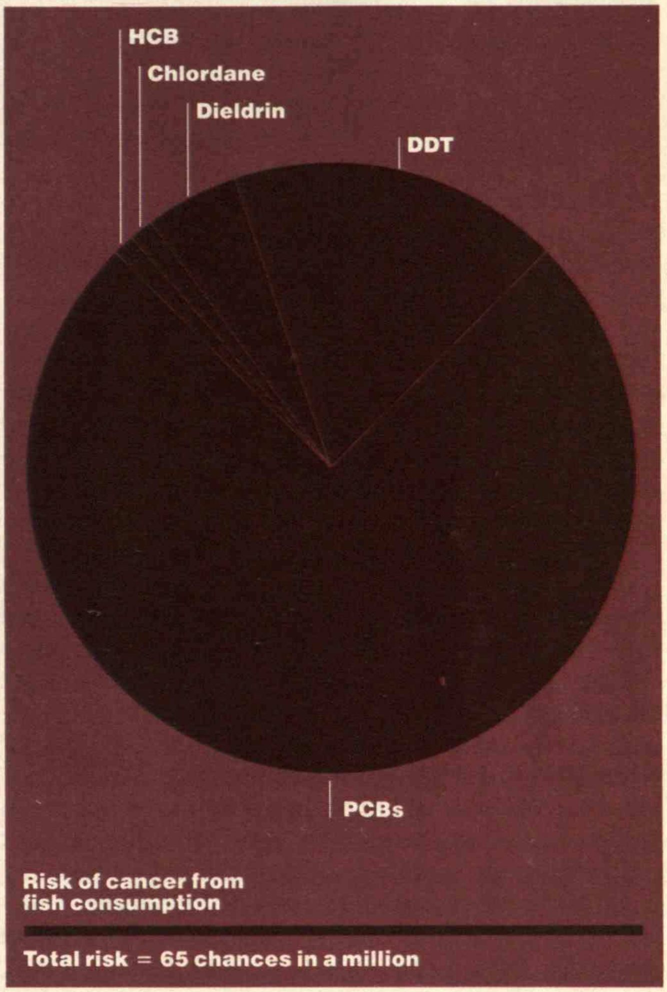
There's no question that toxic wastes are seeping into groundwater and soil from dumpsites throughout the nation. But how do these potential hazards compare with the risks of dumping wastes into shallow water offshore?

Unfortunately, very few studies have attempted to answer that question. Perhaps the most extensive information comes from Nassau County, Long Island, an area where both fish and groundwater risks are high. Offshore lies the New York Bight, the nation's largest dumpsite for solid sludge; onshore, sandy soil and a particularly shallow aquifer combine to make groundwater contamination a problem as well. Based on data available from Nassau County officials, we have been able to compare the health risks posed by the daily consumption of locally harvested fish versus the daily consumption of groundwater.

First of all, the types of organic compounds that contaminate groundwater and fish are quite different. Small, soluble chemical compounds such as trichloroethylene and tetrachloroethylene are usually

For residents of Nassau County, Long Island, the risks of getting cancer from drinking tapwater or eating locally caught fish are similar. The risk from consuming fish is about 65 in a million, while the risk from drinking water is about 34 in a million. Both levels of carcinogenic risk are greater than the threshold that has been considered acceptable by the Environmental Protection Agency. As shown, more than half of the risk from drinking groundwater comes from chloroform contamination; more than 75 percent of the risk from eating fish comes from PCBs. (These risks are based on potency estimates from animal experiments.)





found in groundwater, having leaked from dumpsites; both are common industrial solvents. Conversely, large compounds such as PCBs dissolve poorly in groundwater and tend to cling to surface soils, but they are easily adsorbed and stored by fish. As a result, their concentration in fish is tens of thousands times their concentration in water. Both types of compounds are suspected carcinogens.

We have calculated the total risks of getting cancer from both types of contaminants by multiplying the degree of their potency by their estimated dose in humans. For an average individual weighing 155 pounds, the additional lifetime risk of getting cancer from drinking 2 liters of water a day is 34 in a million—a level of risk three times greater than the 10-in-a-million threshold considered acceptable by the EPA. For the same individual, the increased risk of getting cancer from eating 6.5 grams of fish per day (a mixture of flounder, lobster, and mussels averaged from a normal weekly portion) is 65 in a million. So even though most people drink much more water than they eat fish, the carcinogenic risks of doing either are about the same. For people who consume a large amount of striped bass, the risk of getting cancer is much higher: 2100 in a million. (Striped bass are more toxic because they migrate into the highly contaminated waters of the Hudson River.)

According to this limited assessment, we should be just as concerned about dumping chemical pollutants such as PCBs in shallow ocean waters as we are about dumping them on land. In fact, it might be safer to treat many of the insoluble organic compounds in active land-based systems. On the other hand, the ocean, with its large dilution capacity, is better equipped to handle wastes such as metals. And of course, some industrial pollutants such as dioxin and PCBs shouldn't be dumped at all. It would be much safer to destroy these compounds by incineration or

DIAGRAM: OMNIGRAPHICS

The U.S. must develop a regulatory program that gives businesses and towns an incentive to control their ocean dumping.

develop substitute products or processes that would eliminate the need to dispose of these highly toxic substances.

An Economic Incentive for Safety

All these studies point to one conclusion: we need to make major changes in the way we regulate ocean disposal. The protectionist approach of the 1970s has backfired. Exceptions to restrictions on ocean dumping were granted and deadlines extended haphazardly, often as a reaction to political and economic forces. The United States must develop a regulatory program that recognizes that the ocean should be used for some waste disposal, yet provides an incentive for businesses and towns to control their ocean dumping activities.

One approach we advocate would be to charge a sliding fee for ocean disposal based on the amount dumped, the type of contaminants in the waste, and the location of disposal. Since it is far cheaper to dump wastes in the ocean than on land (no one, after all, can buy or lease the ocean for dumping), a fee system could bring ocean disposal into economic parity with other alternatives. Decisions on where to dispose of waste would then be more likely based on comparisons of environmental and health risks, not on the basis of economic or political expediency.

Under a fee system, disposers of innocuous materials such as seafood-cannery wastes, which contain easily degradable compounds, could be charged low, if any, fees, since uncontaminated organic material poses few threats to the marine environment. Disposers of contaminated wastes, on the other hand, would be taxed according to the type and concentration of pollutants in the waste. This kind of graduated fee would create an incentive for dumpers to either reduce the volume of waste dumped or pretreat it to decrease the amount of contaminants present. For instance, a municipality that was being charged a relatively high dumping fee because of the high concentrations of industrial contaminants in its waste would have an incentive to impose pretreatment requirements on local industries. Indeed, the Clean Water Act already gives municipalities the legal authority to do so.

A variable fee system would also give industry an incentive for developing innovative pretreatment and disposal techniques. The less contaminated the waste a company discharges, the lower the fee would be. Both industry and government could also save on fees (and make some additional income) by processing sludge into fertilizer and other useful products.

A variable fee system could also be used to encourage dumpers to use appropriate dumpsites. Under this system, dumping at deep-water sites shown to have a greater capacity to absorb waste would be charged much less than dumping at shallow coastal sites that are already heavily polluted. The fees could be structured in such a way as to counterbalance the increased cost of hauling wastes further offshore to deeper, more appropriate sites.

Furthermore, revenues generated from dumping fees could be put to valuable use. They could be earmarked for research of alternative waste-disposal techniques and used to finance studies aimed at finding safe deep-water dumping sites. Such revenues could also be used to fund a comprehensive program to monitor dumping and assess its effects on the marine environment. Since our knowledge of the marine environment is rudimentary, any effective system of ocean waste disposal must be accompanied by an ongoing monitoring program.

Finally, we believe a variable fee system would be more equitable than the current regulatory system. For example, the EPA phased out many small-volume municipal dumpers during the 1970s while allowing large-volume dumpers (such as New York City) to continue without penalty. The large municipalities had the legal and financial resources to find loopholes in the system, forcing the EPA to grant them special exceptions. A fee system based on tonnage and contamination levels would eliminate these inequities. In short, we believe such a system is a versatile regulatory tool that deserves serious consideration by America's policymakers.

Further Reading

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There are more than 10,000 dams—large and small—on the rivers and rivulets of the six New England states, according to the New England River Basins Commission. Some 2,200 of the dams not now in use could be developed to produce at least 50 kilowatts of power each, for a total of 1,400 megawatts, enough to save New England about 10 million barrels of oil annually.

	Existing dams	Breached dams	Operating hydro dams	Corps of Engineers flood control dams	Other small dams	Total
Connecticut	1,441	34	21	12	1	1,509
Maine	1,005	246	98	1	68	1,418
Massachusetts	2,286	131	52	14	29	2,512
New Hampshire	2,301	845	125	14	47	3,332
Rhode Island	738	120	2	1	39	900
Vermont	436	69	65	11	418	999
Total	8,207	1,445	363	53	602	10,670

How Small Hydro Is Growing Big

Continued from page 59

at about 8 cents per kilowatt-hour is $8,000 a year. This means the capital investment could be recovered in a little over 9 years even without the available tax credits; those will reduce the payback period to 5 to 7 years.

Personal Hydro: True Energy Independence

To see one of the smallest of all hydro generators, you have to travel to the farm of David Brown in Shutesbury, Mass., where a 15-foot dam on a small stream supplies a generator rated at 4 kilowatts. The flow from the two-square-mile watershed runs as high as 5 cubic feet per second, and generator output has exceeded 1 kilowatt.

In the first half of last year, Brown's one-family generator actually met all the farm's needs. He purchased no electricity during a six-month period when he used to buy about 4,000 kilowatt-hours of power for about $350. The installed cost of the hydro generator was $5,200, $2,700 of which was covered by a Department of Energy demonstration grant. (These figures exclude the cost of refurbishing the dam, which Mr. Brown did himself.) Based on his out-of-pocket costs, the dam would pay for itself even without the DOE grant in a little over 7 years. Farmer Brown now actually looks forward to receiving his electric bill.

The Future: Fulfilling the Dream

To understand the future for small hydro generating units, we have to look to some basics. The amount of electricity that a hydro plant can produce depends on the amount of water available and the distance it falls. The theoretical upper limit of the hydro potential of a site can therefore be estimated on the basis of the size of the watershed, the amount of rainfall, and the differences in local elevations. Based on such factors, the Regional Planning Commission of Berkshire County, Mass., estimates a potential of 140,000 kilowatts for hydro in that county. However, the total capacity of sites identified so far is 13,000 kilowatts—only 10 percent of the potential.

The gap between these figures is striking. Since no identifiable large hydro sites remain in the area, the only way to tap the 90 percent unfilled potential is through smaller units. It is such a "carrot" in every New England watershed that keeps the interest in very small hydro alive.

Though the alternative of purchased power is generally available, the dream of individual stream owners to capture "their" water power is as tantalizing today as it was in colonial times. A typical residence uses 6,000 kilowatt-hours of electricity a year, requiring about 1 kilowatt of generating capacity. At 8 cents per kilowatt-hour, the homeowner is then spending $480 a year for electricity. To install a hydro unit for no more than this annual cost, the "personal hydro" owner must put a unit into place for about $5,000 per kilowatt. This is becoming economically feasible if the landowner doesn't have to build a dam or buy additional land.

Would-be hydro owners should study the strategic differences between the sizable Lawrence and Garvin Falls projects and the tiny Bernardston, Union, and Brown Farm units in the accompanying photos. Even the unpracticed eye can see that the former are full-fledged construction jobs, complete with blasting, very heavy construction machinery, and skilled tradespeople. The smaller units are more like home foundation concrete work and must be treated as a challenge of their own.

There is little question that hydroelectric plants are on the march toward smaller sizes. They can probably be counted on to supply as much as 4 percent of New England's present electric capacity. And individual owners of rushing streams may be able to gain a good measure of energy independence in the bargain.

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Stalking Taboos, Building with Waste, and Saving Energy

Skewering Sacred Cows

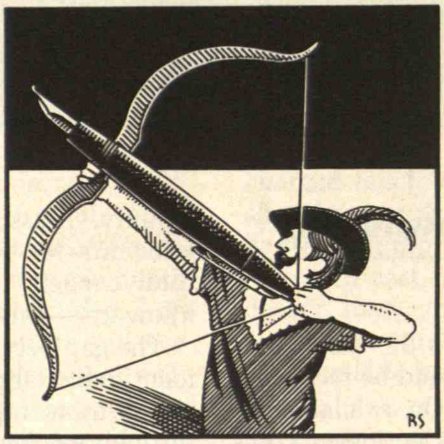
Naked Emperors: Essays of a Taboo-Stalker
by Garrett Hardin
William Kaufman, 1982, $15

Reviewed by Paul R. Ehrlich

The opportunities for getting one's mind boggled seem endless these days—just read a Post Office report on mail delivery after a nuclear war or listen to Sunday TV pundits discuss what's wrong with the world. Getting one's mind expanded is much more difficult, but Garrett Hardin, one of today's best biology writers, has once again come to the rescue.

About half the pieces in this collection of essays were originally published in the last few years, although some are golden oldies. Hardin's tough-minded approach to controversial topics such as overpopulation, abortion, creationism, eugenics, rights, and responsibilities will be familiar to his fans, who know that no cow is too sacred for him to skewer. Many of his conclusions will come as no surprise to the scientifically informed, although they will often find the supporting arguments provocative and the related information fascinating.

For example, biologists know that recent public discussion and congressional hearings concerning when life begins have been preposterous since, as Hardin says, "life never begins—*not in human experience*." Human egg and sperm cells are every bit as much "human life" as a human zygote (the fused egg and sperm cells), fetus, infant, and adult. Hardin points out that two-thirds of early embryos are spontaneously aborted and extends an argument put forward by a Jesuit priest in 1967. If, as antiabortionists wish, zygotes are defined as human beings, "The law (to be consistent) must require every woman to save the flow from each delayed menstruation so that it can be given whatever burial is legally required by the state. With annual births in the United States standing at 3.5 million, there must be something like 7.8 million spontaneous abortions per year. If each of these menstrual flows has to be buried, at a modest cost of $500 per burial, the total cost would be approximately $4 billion



per year—no small sum even in these days of inflation. (We can anticipate, of course, no objection from undertakers to the passage of this law.)"

Those who think that antiabortionists would never go to this extreme should consider some of their views. For example, Hardin quotes Father Austin O'Malley as saying that "an innocent fetus an hour old may not be directly killed to save the lives of all the mothers in the world." And Father Edwin F. Healy maintains that "it is preferable by far that a million mothers and fetuses perish than that a physician stain his soul with murder" by performing an abortion to save a mother's life. Hardin frequently uses such examples to highlight the tendency of many people to throw around words such as "innocent" and "murder" while blithely ignoring the quantitative implications of their statements, a theme he carries throughout his essays.

Although Hardin is deeply concerned about the morality of forcing women to bear unwanted children, he fails to give careful enough consideration to the fact that a substantial portion of our society is offended by the idea of abortion. In my opinion, out of respect for this view, abortion should be virtually eliminated through research, education, and services designed to move us toward a "perfect contraceptive" society. Ironically, of course, many of those in the antiabortion ranks are also opposed to contraception.

Large-Scale Alchemy

Nowhere is the problem of ignorance of science and mathematics better illustrated than in the writings of economist Julian Simon, which Hardin discusses in a devastating chapter called "The Born-Again Optimist." Simon holds, among other astonishing notions, that any resource can be infinitely subdivided and thus is infinite in quantity, and that significant amounts of resources can be produced by large-scale alchemy. Hardin, of course, has a field day with such nonsense. However, I wish he had spent more time discussing how such ideas get into print. Simon's book *The Ultimate Resource* was a product, to its disgrace, of the Princeton University Press, and Simon first aired many of his ideas in *Science*, the preeminent North American science periodical.

In 1980 Simon wrote that "the quantities of a natural resource such as copper cannot be calculated even in principle, because. . . copper can be made from other metals." He goes on to say that "even the total weight of the earth is not a theoretical limit to the amount of copper that might be available to earthlings in the future. Only the total weight of the universe . . . would be such a limit."

Hardin argues that the unwillingness of the Simonesque segments of society to face up to the practical limits to resources (or anything else) can be traced to a deification of progress. In the past 200 years, Hardin claims, it has become heretical to ask "the time-binding question 'And then what?' before we go off half-cocked. . . . The simpleminded concept of progress (largely technological progress) that governed most policymaking during the past 200 years is now under severe attack, and the bitter news of real limits is more than naive devotees of progress can bear. Denying reality, they embrace euphoria. Simon gives them an intellectual base for being born again as optimists."

Rights versus Responsibilities

Hardin contrasts two religions—progress and ecology. The precepts of the first are "(1) The Dogma of Aladdin's Lamp: If we can dream it we can invent it. (2) The Dogma of the Technological Imperative: When we invent it, we are required to use it." In contrast, the precepts of ecology are "(1) The Dogma of Limits: Not all things are possible (though death is!). (2) The Dogma of Temperance: Every 'shortage' of supply is equally a 'longage' of demand; and, since the world is limited, the only way to sanity ultimately lies in restraining demand."

Hardin's insistence on asking "and then what?" will gain him few friends among those who put their faith in infinite technological progress. And his refusal to accept many liberal shibboleths has earned him and will continue to earn him outright hatred in some quarters. His most unpopular views are doubtless those on "rights," the invention of which is still very much in vogue. In "Limited World, Limited Rights," he discusses journalist Shana Alexander's claim that people have a basic right to food, clothing, shelter, and medical care. Hardin supports Milton Friedman's view that "if I have the 'right' to food . . . someone else must have the obligation to provide it. Just who is that? If it is Ms. Alexander, does not that convert her into my slave?"

Proclaiming that people have such rights is all very comforting until one starts doing a little analysis and arithmetic. Is it possible to mobilize the world's resources to satisfy everyone's needs? How much food and clothing does each of 4.6 billion people have a right to? What kind? Does everyone get a shack? An apartment? A home? A mansion? Does everyone have a right to access to a physician? How fast? To penicillin? To interferon? To brain surgery? To a heart transplant? To life-supporting technology for hopelessly defective children? And what happens in half a century when the population has almost doubled to 8 billion people, all presumably with the same rights? Hardin, of course, has long emphasized the fundamental role of overpopulation in today's dilemmas, a fact that many analysts and decision makers ignore.

But although he is superb at pointing out these kinds of problems, Hardin is less successful at pinpointing just what obligation one should feel toward fellow human beings. His basic position is that the nation should be the largest unit of concern, with strong recognition that certain kinds of problems, including managing global "commons" such as the atmosphere, must be dealt with supranationally. I suspect he feels that "love all thy brothers" rhetoric is so widespread he must simply reveal the potential consequences of people possessing many rights but lacking concomitant obligations, such as restraining their reproduction rates. But he exposes himself to being labeled both simplistic and lacking in compassion, even though he seeks to avert "solutions" that ultimately only increase human suffering.

For example, Hardin gives the impression that the plight of poor nations in general and Mexican immigrants in particular is entirely of their own making. However, rich nations have played, and continue to play, important roles in creating those situations. The questions of responsibility and cures for gross economic inequity are very complex and deserve more careful attention than Hardin has given them.

Naked Emperors is a superb book but not one, to use A.E. Houseman's line, "for fellows whom it hurts to think." I would recommend that it be read in every high school, but doing so would be an example of the kind of uninformed optimism Garrett Hardin deplores. Those "fellows" are on school boards and in legislatures everywhere. Perhaps the best hope is to encourage all citizens to think rigorously, quantitatively, and compassionately. Then the problems Hardin writes about will become easier to ameliorate as more and more people learn to recognize the emperor's lack of clothes. □

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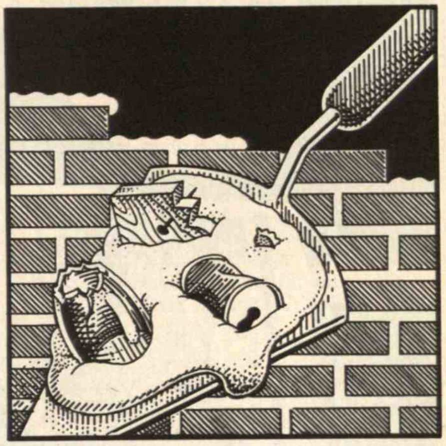
Building with Waste

Building for Tomorrow: Putting Waste to Work
by Martin Pawley
Sierra Club Books, 1982, $17.95

Reviewed by Albert Dietz



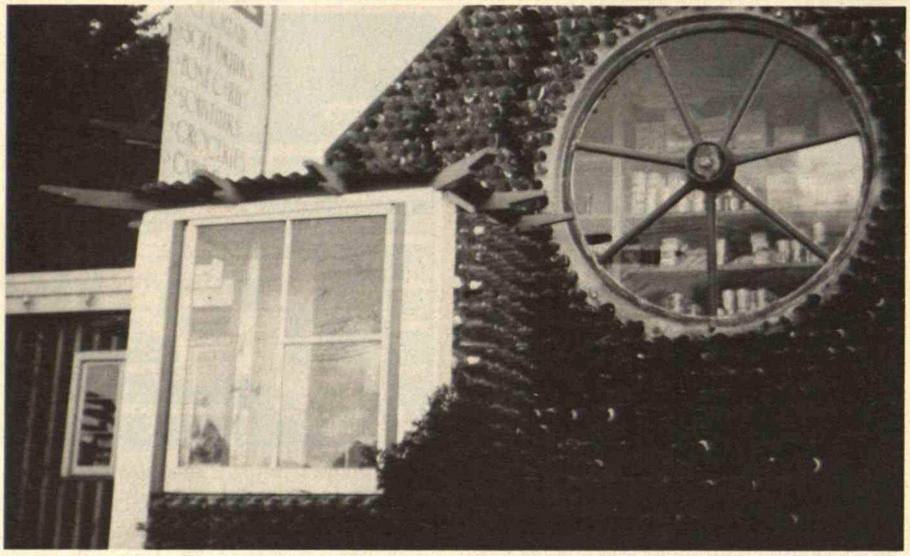
The possibility of using society's wastes as building materials has long intrigued designers and builders as one way to reduce the seemingly intractable costs of construction, especially housing. Martin Pawley has had firsthand experience with experimental houses built of waste at Rensselaer Polytechnic Institute and close contact with other projects in the U.S. and abroad. In *Building for Tomorrow*, Pawley does an admirable job of describing these projects and examining the potentials and problems in using refuse—mainly urban trash and agricultural, mining, and industrial wastes—in building.

Pawley favors using waste directly without extensive remanufacturing, and he devotes most of the book to exploring such uses. For example, one favorite of experimenters has been the huge quantities of bottles and cans produced and discarded each year. People built houses with walls of glass bottles as early as 1912 in locations as scattered as Alaska and New Zealand. Builders have also used steel and aluminum cans assembled around a core of foamed plastic insulation. And Pawley constructed a house using cans and bottles built into a skeleton consisting of the cores of heavy rolls of newsprint. As a demonstration, Reynolds Aluminum Co. built a house using aluminum from recycled cans and other waste materials. The energy expended was considerable though markedly less than if it had been made of virgin materials.

Old cars have been another popular source of construction materials. Experimenters have formed walls with old tires filled with sand and made roofing of tire treads cut and laid flat. Others have assembled discarded car tops into walls and roofs and used metal panels from vans to form the walls of small commercial and industrial buildings. One experimenter even formed the skeleton of a dome with automobile exhaust pipes.

One problem in reusing bottles, cans, and other products is that few manufacturers design them to be directly reused in construction. Alfred Heineken of Heineken Breweries did commission a study to determine whether glass bottles could be made so they would also be suited for use as interlocking bricks. Although the idea proved feasible, no one has developed it beyond the prototype stage. Until manufacturers find it profitable to make such

This house made of bottles was built in New Zealand.



products, remanufactured wastes will be more commonly used in building.

For example, bagasse, or sugar-cane waste, has long been used to make building board, as have old newspapers, straw, and corn stalks. Waste wood is chipped and reconstituted into particle board, and newspapers have been processed into "cellulose" insulation.

Manufacturing by-products are also widely used as building materials. For example, sulfur and sulfur products, extracted from petroleum, coal, and stack gasses, can replace portland cement as a binder in concrete and are used as road-paving material. By-product gypsum sometimes replaces natural gypsum; blast-furnace slag is used as a component of portland cement and as fill.

Trash has been put to widest use by the desperately poor inhabitants of the squatter housing found throughout the less-developed world. During World War II, Pacific islanders eagerly transformed pallets and other shipping containers into housing. Today, unable to afford even the least expensive materials, people improvise rough and rudimentary housing from bits of wood, container board, discarded cans opened and flattened, wrapping paper, cord, strapping, and whatever else they can retrieve from trash dumps. Residents of such shelters gradually replace them with more permanent structures as they are able to procure other materials.

A major problem in reusing many waste materials is the cost of gathering and transporting them. For example, the vast quantities of mine tailings and quarry waste are usually discarded in remote areas. Bagasse, on the other hand, is used to make building products because the raw wastes are available at economical shipping distances.

Another problem in using waste is that disposing of debris is frequently cheaper than sorting it for reclamation. The large quantities of wood, metal, brick, and stone from demolished buildings are sometimes separated for reuse, but concrete and most masonry are usually thrown away. Labor is seldom cheap enough and steel expensive enough, except in some developing countries, to justify hand cleaning and recycling of steel reinforcing bars from demolished concrete structures.

Many other practical problems abound to trap the unwary in using waste. For example, dissimilar materials must be combined with care—aluminum cans should not be set in alkaline mortar. And some experimental bricks made of compacted refuse have decomposed.

But even with these problems, interest in reusing waste is growing as suitable dumping sites become scarce and the costs of hauling urban waste to outlying areas mount. In light of these rising costs and diminishing resources, the huge amounts of refuse society generates constitute an attractive, if still baffling, potential source of building materials. □

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Measuring Energy-Efficient Design

Economics and Building Design
by William T. Meyer
McGraw-Hill, 1982, $39.50

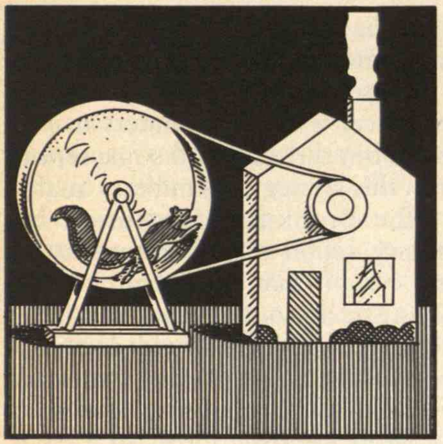
Reviewed by Jay Luboff

So many new books about energy conservation have been published in the last decade that one wonders whether a new publication could make a significant contribution. But William T. Meyer's *Energy Economics and Building Design* does just that. Uniquely comprehensive, this book allows professional designers to jump into the subject of energy-efficient design and come out with a working ability to analyze the impact of various choices on the client's pocketbook.

Meyer's step-by-step "design evaluation process" enables anyone to identify the heating and cooling characteristics of various home designs. He also explains, in simple terms, different ways to calculate the costs and benefits of each alternative, including simple payback and net present value. Meyer provides numerous examples of energy-efficient residential and commercial design, as well as tables, charts, and formulas vital to the designer.

However, energy-efficient design, and hence manuals such as Meyer's, will have limited appeal until the housing industry takes energy efficiency into account in daily business procedures. To correct this situation, key lenders, appraisers, and designers, in conjunction with the Western Resources Center at the University of Washington, have developed the Shelter Industry Residential Energy Efficiency Evaluation Program. This model program involves voluntary, cooperative integration of a "uniform energy rating system" (UERS) into housing financing and marketing practices. The goal is to provide information to all sectors of the marketplace—especially potential homebuyers—about the relative energy efficiency of residential properties. Mortgage lenders in Portland and Seattle have taken the lead in pilot programs, which are now being expanded throughout the Northwest with funding from the regional Bonneville Power Administration.

The need for an energy rating system was first recognized by appraisers and mortgage lenders, who reasoned that they



could not accurately gauge the market value of improvements designed to increase energy efficiency or estimate homeowners' monthly savings from those improvements. Homebuyers, builders, and designers of energy-efficient homes have long been frustrated that the mortgage-loan process does not take such savings into account. The opportunity seemed ripe for an industrywide effort to add E (energy costs) to the traditional P (principal) + I (interest) + T (taxes) and + I (insurance) calculation of the mortgage-lending process.

Considering energy efficiency in the lending process can significantly affect the ability of homebuyers to qualify for a mortgage, as well as the market value of a home. One lender estimates that a $10 monthly saving in energy costs equals a .25 percent reduction in interest costs for a $50,000 home with a 30-year mortgage. Thus, in some cases, homeowners participating in the UERS have been able to qualify for houses worth an additional $4,000.

Book Value

The UERS was designed to be technically sound yet easy to use. The system includes a set of ratings for the energy characteristics of a home, including insulation levels, passive solar gain, window characteristics, frequency of air changes, and water-heating efficiency. Evaluators use a 100-point scale to total the potential energy savings from all these space- and water-heating options. This score is then translated into a simple qualitative rating of poor, fair, good, efficient, or very efficient. Thus, the rater need only identify the type of energy-efficient options that exist in the house, circle the appropriate boxes on the rating sheet, and total the score.

Currently seven rating sheets are being used to evaluate various types of single-family homes, with another seven being developed for multifamily structures. And both the qualitative ratings and point scores can be adjusted to account for climatic conditions around the country. Thus, rating sheets that can be used to evaluate 80 percent of the housing stock in the United States will soon be available.

A last feature of the UERS allows evaluators to estimate potential annual energy use and costs. The rater combines the qualitative rating with a projection of typical energy use for the specific size and type of home, an estimate of furnace efficiency, and current costs from local utilities. A manual accompanying the rating sheet provides these figures. The entire rating process takes less than 30 minutes.

The methods for calculating heat loss are the key to making the ratings accurate. Utilities, state energy agencies, and the Bonneville Power Administration are cooperating to test which methods produce the most reliable predictions of home energy use.

Of course, energy consumption varies according to the lifestyle of each family. The rating given a home is therefore designed to reflect "efficiency potential," similar to the EPA mileage rating for automobiles. Even though people's home "driving habits" will vary, a "gas-guzzler home" will still use significantly more energy than a "VW home." The UERS will convey this kind of relative rating to the homeowner or prospective homebuyer.

Should the experiments in the Northwest prove successful, building designers may want to use Meyer's book to calculate not only the potential annual savings from a particular energy-efficient design, but also the "book-value" accruing to the client whose energy-efficient home depreciates less than an energy-guzzling home. In either case, the book is a treasure house of knowledge on energy options and will easily repay the purchase price many times over in energy savings. □

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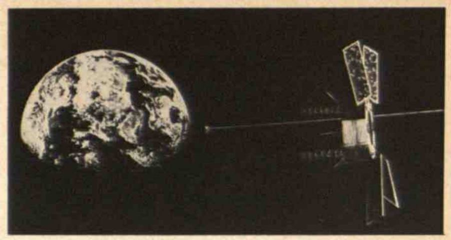

Strategic Command and Control

Continued from page 49

a nuclear attack on Washington, it seems unlikely that it would be possible to determine which officials had survived and who should take over. There would probably be a serious breakdown of government authority, making it extremely difficult to execute a retaliatory strike. Thus, contingency plans have surely been prepared that would ensure retaliation in the event of such a "decapitating" attack.

Although such plans are highly classified, one possibility is that if the president and other national leaders were killed, the authority to launch nuclear weapons would pass automatically to the SAC commander-in-chief, who would presumably be safely airborne in the Looking Glass plane. If he were also killed or unable to take command, a final guarantor of defense would be the ability of subordinate commands to retaliate without official authorization, a contingency known as "permissive action."

Indeed, a certain amount of evidence suggests that the capacity to launch nuclear weapons has been dispersed to a large number of people in direct contact with strategic forces. For example, if a massive attack interrupted all military communications to ICBM bases, the missile-combat officers in underground capsules would probably be able to launch their weapons without the go-code and a confirming "vote" from another missile unit.

U.S. submarine officers may also be able to fire on their own initiative under tightly defined circumstances. If a submarine captain were to suddenly find himself without communications and he suspected that a massive nuclear attack had occurred, he would presumably have to verify this by attempting to contact the national command authorities with various radio systems, monitoring news broadcasts, or sampling the air for radioactivity. If an attack were confirmed, the captain might be able to activate the electrical firing circuit without the usual authenticator codes by carrying out a complex procedure requiring several crew members.

If such options exist, lower levels of the chain-of-command could eventually retaliate even if the entire national civilian and military leadership were killed. The most successful surprise attack by the Soviets might destroy all U.S. land-based missiles, bombers, and submarines in port, yet U.S. submarines at sea would still possess 3,000 warheads—more than enough to devastate the Soviet Union. Soviet commanders of missile submarines probably have similar permissive-action authority.

Such latitude for lower-level commanders may in fact add to deterrence, but there are also some serious dilemmas inherent in this strategy. As military analyst Richard Betts of the Brookings Institution has pointed out, permissive action is a deterrent if it can be made absolutely certain that decentralization of the command structure occurs *only* in the event of the confirmed death of civilian and military leaders or irrevocable disruption of the C³I network. Otherwise both sides might fear that the opposing leadership would lose control of its strategic forces in a crisis, and hence each might be tempted to strike first. Thus, a policy of permissive action seems very dangerous—hardly a long-term solution to the problem of command-structure vulnerability.

Can Nuclear War Be Controlled?

The C³I modernization currently underway will almost certainly ensure that the United States has a reliable and prompt second-strike capability, which is all to the good. But the upgraded C³I system would probably not function for more than a few hours after an attack of 50 to 100 warheads—a small fraction of the 8,000 in the Soviet arsenal. Even if C³I systems could—at enormous cost—be made hardened and redundant enough to endure a series of limited nuclear exchanges over a period of weeks, the notion of controlled escalation is little more than the Strangelovian pipedream of a few defense strategists.

As military scholar Desmond Ball has pointed out, the force-multiplier effect of C³I gives the adversary a strong incentive to attack the system, even if the result is to force the conflict into an uncontrolled, "spasmodic" mode. Likewise, since the force-multiplier effect can operate only as long as the C³I system is working, each side has a strong incentive to use its strategic forces quickly before central control is lost. Thus, even a limited initial use of nuclear weapons would generate strong pressures for rapid escalation, including attacks on enemy command-and-control centers. Unfortunately, attacks on C³I systems would also preclude an early end to a nuclear war. (Although the Reagan administration recently recommended upgrading the teletype "hot-line" link with the Soviet Union, that link, too, will remain vulnerable to the effects of nuclear explosions.) Central

Submarines are the most durable leg of the U.S. strategic forces, but communicating with them is difficult. The Pentagon is developing a variety of new systems, including lasers, for this job. The USS Ohio, with crew working in its control room, is shown at the left. The great accuracy of the boat's Trident missiles depends on a network of satellites, called NAVSTAR, that will be fully operational by 1987. NAVSTAR (artist's drawing, opposite page) can pinpoint a Soviet missile silo to within 30 feet.

control would soon be lost, eliminating the ability of opposing leaders to negotiate an end to the war before mutual devastation.

A nation that began a limited use of nuclear weapons, in the hope that successive exchanges could remain controlled, would therefore be taking an enormous gamble. In the words of former Defense Secretary Harold Brown, such a move would be "a cosmic throw of the dice." In his 1979 Department of Defense annual report, Brown wrote, "None of this potential flexibility changes my view that a full-scale thermonuclear exchange would be an unprecedented disaster for the Soviet Union as well as for the United States. Nor is it at all clear that an initial use of nuclear weapons—however selectively they might be targeted—could be kept from escalating into a full-scale thermonuclear exchange, especially if command-control centers were brought under attack."

Indeed, efforts by the United States to achieve the capability to fight a protracted war in the name of "deterrence" may have the opposite effect—either by deluding military and civilian leaders into believing that nuclear war is controllable and winnable, or by provoking the Soviets rather than deterring them. Combined with the increasing effectiveness of U.S. antisubmarine capabilities, which threaten the most survivable prong of the Soviet arsenal, current U.S. nuclear forces and doctrines must seem exceedingly threatening to the Kremlin. For example, the Pershing II intermediate-range ballistic missiles to be deployed in Europe this December will be capable of striking Soviet command centers within eight minutes of firing, and may perhaps force Moscow into adopting a launch-on-warning policy.

Instead of developing weapons and strategies that undermine the stability of the strategic balance, there is an urgent need to develop policies that strengthen stability during a crisis. Stability would be increased if neither side believed it could come out ahead after a nuclear exchange and hence had no incentive to strike first. One way to ensure crisis stability would be for both superpowers to devise a leakproof defense against nuclear attack—the goal that President Reagan referred to in his March 1983 "star wars" speech. But because such defenses will not be technologically feasible for many years, if ever, the best alternative is to make sure the strategic forces of both sides can withstand a first strike without threatening one.

Upgrading C^3I capabilities will be more stabilizing if pursued in the context of arms-control agreements that limit offensive nuclear forces. Several C^3I-related items should be added to the administration's arms-control agenda:

☐ A ban on the testing of submarine-launched ballistic missiles in low-altitude flight, since that greatly shortens the time required for warheads to reach their targets and could reduce early warning of a surprise attack.

☐ A reaffirmation of the ban on nuclear weapons in orbit and deep space established by the Outer Space Treaty, with the aim of preventing the deployment of orbiting EMP weapons.

☐ A ban on producing and deploying "enhanced-EMP" weapons, which could be employed in a first-strike counter-C^3I attack.

☐ A mutual ban on developing antisatellite technology. If antisatellite weapons are widely deployed, the whole spectrum of space-based systems on which C^3I depends will be in jeopardy.

The Reagan administration should seize the current Strategic Arms Reduction Talks (START) as a precious opportunity to restore stability to the East-West balance. If the superpowers can agree to limit their offensive forces to a retaliatory role, while continuing to make their C^3I systems sufficiently hard and redundant to ride out a surprise attack, we will have taken a great step toward a safer and more secure world.

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PHOTOS: U.S. NAVY

Labeling Chemicals: What's in a Name?

Regulation of chemicals in the workplace has typically consisted of a series of specific standards for specific substances. For example, in 1973 exposure to vinyl chloride was closely linked to fatal liver cancer in several workers at a Kentucky plant. The U.S. Occupational Safety and Health Administration (OSHA) responded to the public outcry by issuing a standard limiting workplace exposure to that widely used chemical. Today labor unions are asking OSHA to limit exposure to benzene, which is suspected of causing leukemia. But at least 50,000 chemical substances that could be used in the workplace are toxic, according to the National Institute for Occupational Safety and Health (NIOSH), and enforcing, not to mention devising, regulations for every one would be an administrative nightmare.

An alternative approach rapidly gaining favor is based on providing better information about chemical hazards in the workplace. Within the next six months OSHA will issue a regulation giving workers the "right to know" when they are being exposed to hazardous chemicals. With this new information, workers will supposedly be able to adopt safer practices and make more informed job choices. However, labor unions and environmentalists are supporting stronger right-to-know laws on the state and local level, with the goal of inducing employers to use safer and cleaner production technologies.

The need for a "right to know" regulation was initially suggested by an OSHA advisory committee in 1974. The National Occupational Hazard Survey done by NIOSH in the early seventies discovered that in 70 percent of the cases of exposure to chemicals in the workplace, the chemical was identified only by trade name (often an obscure label such as PX-27). According to Richard Youngstrom, occupational hygienist for the International Union of Electrical, Radio, and Machine Workers in Massachusetts, even the company using a chemical often does not know what it is and cannot take the proper precautions because the chemical manufacturer keeps its ingredients secret.

Though chemicals come with warning labels, these generally offer little help, says Youngstrom. "The warnings on most materials are very general, like 'avoid breathing excessive vapors,' and they appear only on the original bulk containers. When the materials are transferred to smaller containers, the worker doesn't see any warning at all."

Nothing was done on the federal level to deal with this problem until the end of the Carter administration, when OSHA chief Eula Bingham proposed a right-to-know regulation. It was opposed by the chemical industry as being too sweeping and unenforceable and was withdrawn by Reagan's new OSHA administrator, Thorne Auchter.

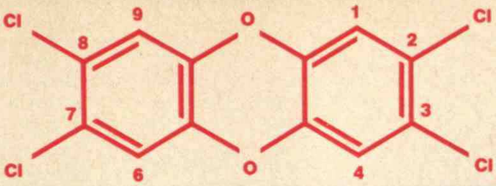
Meanwhile, efforts to pass right-to-know legislation gathered strength at the state and local level. Perhaps ten states, including New York and California, as well as several cities such as Philadelphia and Vallejo, Calif., have passed their own right-to-know laws. In other states, particularly New Jersey and Massachusetts, right-to-know bills are being hotly debated.

In response, OSHA reversed itself and last summer began holding public hearings on a new right-to-know rule, which it calls a "hazard-communication" standard. The Chemical Manufacturers Association (CMA) is supporting the proposed OSHA standard. According to Randal Schumacher, director of health, safety, and chemical regulation for the CMA, chemical manufacturers are willing to label all containers of hazardous materials and to supply customers and employees with data sheets showing a material's potential hazards.

The chemical industry just wants to avoid a patchwork of state laws different from the proposed federal standard, Schumacher explains. OSHA estimates that its proposed rule would cost industry about $580 million to start with and $230 million annually, but state right-to-know laws would cost substantially more, depending on how strict they were and how much they differed from each other.

Unions do not oppose a uniform national standard in principle, but they are dissatisfied with the proposed OSHA regulation because it would allow chemical manufacturers to decide what is hazardous. Charles Richardson of the Philadelphia Project on Occupational Safety and Health explains, "They obviously won't tell you that something is hazardous if they're exposing you to it." The OSHA standard would give manufacturers wide latitude to designate a chemical as a trade secret, in which case the ingredients need not be revealed. And manufacturers could decide whether containers should be labeled with chemical names, generic names ("halogenated hydrocarbons" instead of

ILLUSTRATION: ELIZABETH SLOTE



vinyl chloride), or trade names. Giving companies such leeway opens up possibilities for abuse, says Richardson.

Labor unions are therefore supporting stricter state right-to-know laws. Bills currently before the Massachusetts and New Jersey state legislatures would require all chemicals on a list of hazardous substances to be labeled with the precise chemical name. Manufacturers would have to prove that any product claimed as a trade secret is in fact unknown to the competition. Many bills also give the community surrounding a plant the right to know what is being used. "Hazardous chemicals are not just a problem for labor," says Laurie Kellogg of the Mass. Coalition for Occupational Safety and Health. "Toxic wastes were once inside the factory."

So far right-to-know laws have produced neither dramatic costs nor benefits, and the chemical industry has not been seriously affected, says Schumacher. On the other hand, the 1981 Philadephia right-to-know law has not had much effect because companies are simply required to make public the various chemicals they are using, not their location or amounts.

However, business groups and labor unions are fighting over more than the immediate costs and benefits. The proposed OSHA hazard-communication standard leaves many labeling decisions up to the employer. By contrast, Kellogg and other proponents of a strong right-to-know law hope that it will "give workers and community residents the information they need to play a larger role in decisions that affect them."—*Michael Mandel* □

Environmental Protection Agency (EPA) workers sample debris from the dioxin-contaminated town of Times Beach, Mo. The chemical structure of the culprit, 2,3,7,8-TCDD, is shown above. Despite widespread concern about dioxin, no deaths have been attributed to it at Times Beach.

How Dangerous Is Dioxin?

Dioxin has lately been the most discussed hazardous chemical in the popular press. First came the federal government's decision to buy out the dioxin-contaminated town of Times Beach, Mo. Next came the news that at the behest of the Dow Chemical Co., the U.S. Environmental Protection Agency (EPA) had deleted mention of a connection between Dow and dioxin in a study of contamination in the Great Lakes. More revelations about the chemical surfaced in a class-action suit in which Vietnam veterans are blaming their health problems and childrens' birth defects on dioxin in the defoliant Agent Orange. Evidence indicated that chemical companies manufacturing Agent Orange discussed dioxin's hazards among themselves as early as 1965.

Yet the actual dangers of dioxin remain unclear. Matthew Meselson, a professor of biochemistry at Harvard whom the EPA has consulted regarding dioxin, echoed the sentiments of many responsible scientists when he said that "there may be a serious problem or . . . there may not." Just what *is* known?

Dioxin is not manufactured deliberately but frequently appears as an unavoidable trace contaminant in chlorophenols—chemicals used as pesticides and herbicides. The 72 million pounds of Agent Orange the United States spread over South Vietnam were tainted by a mere 368 pounds of dioxin—or more precisely by 368 pounds of "2,3,7,8-TCDD." This chemical, which is actually one member of a family of about 75 dioxins, is generally considered the most dangerous and is usually referred to simply as "dioxin."

Today, silvex and 2,4,5-T—two herbicides that are the chief sources of dioxin contamination—are "probably" no longer being produced in this country, according to Donald Barnes, science advisor to the EPA assistant administrator. Furthermore, dioxin has two qualities that should lower its chance of contaminating humans: it clings tenaciously to soil particles and dissolves poorly in water. Yet once in water, it concentrates so readily in fish that an EPA draft document on water quality set a safety standard of less than 1 part per quintillion (1 followed by 18 zeros).

Dioxin also finds its way into the environment via wastes from chemical-manufacturing plants. The waste oil that contaminated Times Beach probably came from a chemical plant, and other dioxin-laced wastes have commonly been dumped in drums in landfills. High concentrations of dioxin have been found in fish in the Tit-

PHOTO: WIDE WORLD

tabawassee River, which runs by Dow's plant in Midland, Mich., and more recently in fish in several other Michigan rivers. Dow has not allowed EPA to examine its effluents, saying that these dioxins in fish are the result of combustion. Barnes says EPA has seen "very small amounts" of dioxin from burning of municipal waste but does not believe that combustion is the major source.

Several minor uses of the dioxin-tainted chemical 2,4,5-TCP pose particular threats to humans, according to the EPA's book *Dioxins*. This chemical is used in sickrooms and food-processing plants to kill bacteria.

No ordinary poison, dioxin is picked up, almost as if expected, by a very specific receptor molecule in animal cells. There, chemicals formed from the dioxin tamper with genes and cause cancer. Dioxin also causes cells to produce excess amounts of certain enzymes that promote chemical reactions, leading to a variety of other illnesses.

Studies of the actual effects of dioxins on human beings are scant, so researchers have often turned to animal studies. They have found carcinogenic as well as more immediate toxic effects in animals at extremely small doses. Five parts of dioxin per trillion in food have killed guinea pigs outright and caused several different cancers in rats. Five hundred parts per trillion in food have killed monkeys, and fifty parts per trillion have caused them a variety of reproductive ills. Dioxin's potency may explain why it has been used as a tool in cancer research, says Ellen Silbergeld, chief toxicologist at the Environmental Defense Fund.

Sensitivity to dioxin among different kinds of animals varies by a factor of 5,000, even after differences in body size and metabolic rates are accounted for. Though they do not understand why, some scientists suspect that humans fall on the less sensitive side of the spectrum. Hence dioxin has caused people less harm than might be expected from animal data. Although it is agreed that dioxin can be highly toxic if taken orally, no deaths have been attributed to it at Times Beach or Love Canal from short-term toxic or long-term carcinogenic effects. (However, it may be too early for cancers to have appeared.)

Chemical workers exposed to dioxin chronically or in accidents may be among those who have suffered the most—in part from chloracne, a serious skin condition resembling a bad case of acne. An internal Dow report on an outbreak of chloracne in 1964 at the Midland, Mich., plant, turned over to the court in the Vietnam veterans' case, states: "Fatalities [from dioxin] have been reported in the literature." Another Dow report turned over to the court says "suspected fatalities" from dioxin occurred in Germany in 1955. However, Dow disputes that dioxin truly caused any deaths.

Chemical workers exposed as long ago as the late forties "don't seem to die earlier," says Robert Neal, president of the Chemical Industry Institute of Toxicology. However, he concedes that some workers heavily exposed to dioxin did show evidence of liver damage and "nervous system involvement." Other health problems resulting from dioxin include elevated blood cholesterol levels, immunological disorders, and personality changes.

Marion Moses, a doctor now at Johns Hopkins University who has examined hundreds of dioxin-exposed workers, emphasizes that these disorders are reversible. But Samuel Epstein, a doctor at the University of Illinois's School of Public Health, recently testified before Congress that many harmful effects of dioxin can become "chronic."

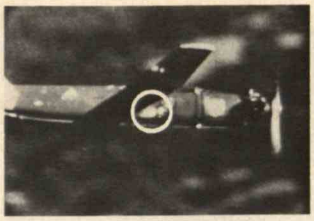
In addition, dioxin may promote a rare group of cancers—the soft-tissue sarcomas. Soft-tissue sarcoma caused 4 out of 105 deaths among workers exposed to dioxin who were part of four separate studies combined by Patricia Honchar and William Halprin, scientists at the National Institute for Occupational Safety and Health. This is at least 40 times the expected death rate from soft-tissue sarcoma.

In Midland, the location of the Dow plant where dioxin contaminates the soil and river, there was an 80 percent increase in soft-tissue sarcoma among females from 1970 to 1978, according to Epstein. And a Swedish study found five times as much soft-tissue sarcoma among forestry and agricultural workers exposed to dioxins (not always 2,3,7,8-TCDD) as among their unexposed counterparts.

Dioxin may cause other cancers as well. In hearings last April before the House Veterans Subcommittee on Compensation and Pension, Epstein testified that about 200 testicular cancers, mainly seminomas, were found in one group of some 5,000 Vietnam veterans. He cautioned that epidemiological analysis was lacking, but added that fewer than 2,000 seminomas are diagnosed annually in the entire white U.S. population and fewer still among blacks.

Three studies released last January at the International Symposium on Herbicides and Defoliants in War in Ho Chi Minh City, Vietnam, suggest that dioxin may cause birth defects. In one study of the families of 40,000 North Vietnamese soldiers, children of those exposed to dioxin in South Vietnam had 40 percent more birth defects than children of those who had remained in North Vietnam. A second study found that fathers of children with birth defects were three times as likely to have fought in the south as the fathers of normal children. John Constable, senior surgeon at Massachusetts General Hospital, and Maureen Hatch, a doctor at Columbia University School of Public Health, who were both present at the symposium, agree that despite some methodological problems, the studies deserve careful consideration.

Although unassailable scientific proof is not yet in, the evidence suggests that dioxin does pose serious health hazards to humans. But among most residents of the United States who live and work away from chemical plants and waste dumps, dioxin has almost certainly caused less damage than some of the environmental disasters that have gained attention in recent years, such as lead in gasoline and peeling paint. The reason is mainly that there is so little dioxin in the environment compared with lead. Chemicals contaminated with dioxin are being made in smaller amounts today, says the EPA's Barnes, and improved production methods are further reducing the level of contamination.—*David Holzman* □



A laser weapon shot down this drone airplane in a 1973 test widely cited by proponents of the Airborne Laser Lab (ALL) project. The series shows the beam of the laser (circled in white) hitting the model below the wing and the explosion that followed. Critics point out that the target plane was slow and easily destroyed, and that the ground-based laser did not have the problems that would occur on a moving, vibrating airplane.

A Laser Weapon Fizzles

Thirteen years ago the air force began the Airborne Laser Lab project. The ALL is not a laboratory in the ordinary sense but a transport aircraft equipped with a 5-megawatt laser. The notion was that the laser would be able to zap both air-to-air and ground-to-air missiles in air battles. In recent years, sponsors have attempted to redirect the ALL to the now-fashionable purpose of zapping incoming intercontinental ballistic missiles, providing a defense against nuclear weapons. Costing $90 million a year, the ALL has accounted for nearly half the Department of Defense (DOD) budget for laser weapons.

But the ALL never passed any significant tests, and was included on an air force list leaked to the *New York Times* last May of possible program cuts to offer Congress. In June the House Armed Services Committee deleted all funding for the ALL, and a staffer says the committee will not compromise on this position. As a result, the postmortems are already coming in.

Even many advocates of laser weapons consider ALL a painful example of what happens when an apparently promising weapon gets pushed too quickly into development. Some critics think its difficulties point to basic technological problems that may bedevil all laser weapons.

"It's an interesting coincidence that the strongest opponents of the Airborne Laser Lab are also pushing for space laser weapons," observes Dr. Aden Meinel, a professor of optical sciences at the University of Arizona and a defense consultant. He speculates that space laser advocates are opposing the flying laser because it may call attention to technical problems and cost overruns that could someday also plague an orbiting laser program.

At first, researchers were confident that current lasers and aircraft could easily be assembled into a complete weapons system. But there were problems:

□ A laser can destroy a target by burning a hole in it, but researchers discovered that most of the infrared light (or heat) used by the ALL reflected away from targets. And even if most of the energy were absorbed, the amount needed might be far more than the ALL's 5-megawatt beam, according to a 1981 Defense Advanced Research Projects Agency (DARDA) survey of laser weapons projects.

□ Even a sufficiently powerful laser will be ineffective unless it can be kept pointed on the target long enough, but an airplane is subject to both vibrations and large jolts. "It's like trying to shoot from the back of a galloping horse," explains a member of the staff of laser-weapon enthusiast Sen. Malcolm Wallop (R-Wy.). The staffer hastens to add that space-based laser weapons would not suffer such problems.

□ The technology required to focus a beam on a distant target has not matured enough to make a battle-ready laser. Basic laws of optics show that lenses for short-wavelength (visible and ultraviolet) lasers are easier to focus, but long-wave (infrared) lasers were the first to be developed and so far are the only kind powerful enough to be used as weapons.

These technological problems have inspired some strange reporting of test results. Meinel complains of a 1973 demonstration at the Sandia Optical Range in New Mexico in which a 100-kilowatt infrared laser on the ground shot down an airplane. This test was made into a promotional film, *Delta*, for the Kirtland Air Force Base Weapons Lab and has been hailed by ALL researchers there as proof that their concept is feasible. But according to Meinel, the target was "literally a big model airplane"—a slow-flying wood-and-fabric drone. The laser destroyed it because the fuel tank, protected only by cloth, exploded when the beam hit.

A more significant test occurred in June 1981, when the ALL tried unsuccessfully to destroy a Sidewinder missile designed to be used in air-to-air combat. It's unclear whether the beam hit the Sidewinder but failed to disable it or missed entirely, as the incident was classified.

In addition to these problems, the basic mission of the ALL—to shoot down anti-aircraft missiles—has been questioned by strategists. They assume that any technology available to us will also become available to our opponents. A laser that can zap anti-aircraft missiles can also zap aircraft themselves. Thus, if both sides sent up laser-equipped aircraft, *all* airplanes in the sky would be destroyed—a laser can't be stopped. In fact, a 1981 DARPA study predicted that beam weapons will make warplanes obsolete.

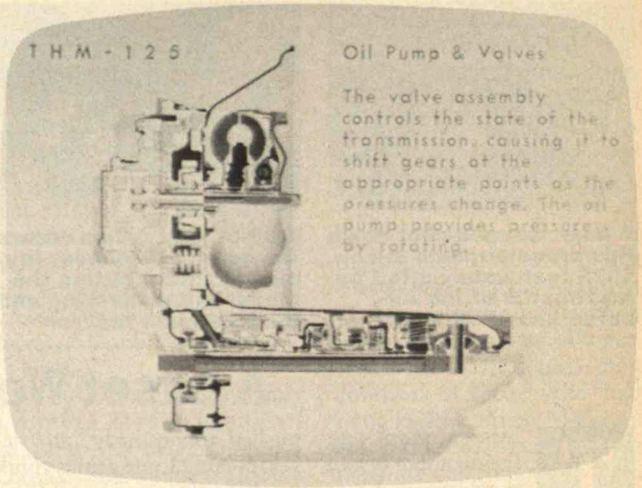
Of course, weapons programs often encounter problems. But as a recently leaked

PHOTOS: U.S. AIR FORCE

Air Force study called "Affordable Acquisition Approach" revealed, the ever-rising costs and ever-expanding schedules typified by the ALL project have worsened recently. The chief villain identified by the study is tactfully called "external management impact." That is a euphemism for congressional flip-flops, upper Pentagon management that resists change, and interservice rivalries that keep misguided projects from being either corrected or halted.

One factor that may have kept the ALL alive so long is the person in charge of it in the seventies, Gen. Donald Lamberson. Having promoted the project, he would not want his career clouded by seeing the ALL declared a technological cul-de-sac. Early in 1982 he was promoted to coordinate all DOD laser-weapons programs. This outraged Sen Wallop, who accused Lamberson of being "committed to salvaging the worst boondoggle in the field, the ALL—a weapon without a mission and a test bed wholly inappropriate for working out the problems of space lasers." Another high-ranking godfather to the project, Hans Mark, now deputy director of NASA, pushed for the ALL in his days as secretary of the air force in the Carter administration. If a Democratic administration were to come in, Mark could once again have a lot of clout, another factor that may have given the ALL a boost.

The prejudices of the branches of the armed services have also plagued other laser-weapons projects. According to Wallace Henderson, a vice-president of BDM Corp., a think tank frequently consulted by the government on defense matters, the decisions on how to base laser systems have often been poor. The navy tried to put a laser weapon on a ship, where fog and clouds kept it from working. The army mounted one on a tank, only to have the weapon blinded by battlefield dust and smoke. Naturally the air force placed theirs on an airplane. The results were no more successful, though they certainly were more costly.—*Carolyn Meinel* □



The Plastic Library

Plastic video disks, originally developed to record movies, are now being used to store digital computer data. Each 12-inch disk has an enormous capacity, equivalent to 2 million pages of text or ten years of the *New York Times*, according to Robert Nelson, vice-president of Laserdata, Inc., which is marketing a video-disk storage system. Furthermore, Laserdata's system can search a disk for all references to a given word in about one second. Another company, Access Unlimited, is developing an even faster system.

The video disks will soon be competing with "on-line databases"—electronic information files on everything from the stock market to wine making that people with personal computers can tap via telephone. For example, "Lexis," which maintains a list of all legal precedents in the United States and is the largest database in use, fits onto four 12-inch video disks, each of which will cost about $100. Previously, using conventional magnetic storage techniques to record "Lexis" would have required "two or three desk tops stacked with hard disk packs," says Robert Lippencott, director of video-disk projects at WGBH, Boston's public television station.

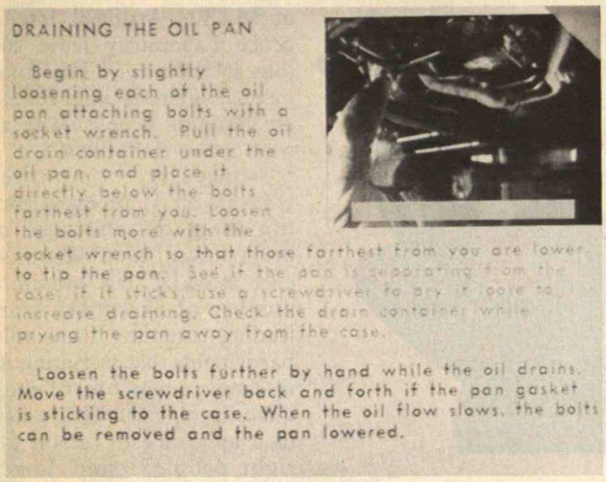
Most databases will fit onto a single disk and will be sold on a subscription basis—updated disks will be sent out at regular intervals. Laserdata claims that video disks will be cheaper than on-line databases for anyone who taps into the information for three or more hours per week. And while literature searches provided by databases usually yield only lists of references—electronic indexes, in effect—video disks can furnish the text and graphics of relevant articles.

The ability of video disks to store images offers other advantages. "Patsearch," developed by Online Computer Systems, details about 900,000 patents granted in the United States. Currently users search the database with key words and receive a detailed description of the patented object. Online Computer Systems will soon offer a version of the database encoded onto a video disk, which will retrieve the plans of the patented objects as well as the descriptions—a valuable feature for would-be inventors.

However, video disks are unlikely to replace on-line databases completely. For instance, "Newsnet," a database offering access to almost 150 newsletters, is continuously updated as new issues come out and would not be well suited to distribution by video disk. Video disks are to electronic databases much as books are to newspapers.

With their large storage capacity for text and graphics, video disks will also have educational uses. A computer-based instruction manual being developed by M.I.T.'s Architecture Machine Group uses a video disk to describe maintenance and repair procedures for a General Motors automatic transaxle transmission. By combining text, photographs, video, audio, and computer

The automatic transmission (shown on screen at left) is actually a touch-sensitive table of contents for a computer-based repair manual being developed at M.I.T. By touching a given part of the transmission, one can summon up repair information in the form of text, photographs, video segments, computer graphics, and actual shop sounds. Video disks, previously used to show feature-length movies on television sets, store the vast amounts of information necessary for this manual. Instructions for draining the transmission oil are provided by text with an accompanying photograph (center), and a full-frame picture (right) warns against a common mistake.



graphics, the video disk allows trainees to choose the style of instruction most suited to their needs. For instance, in trying to diagnose a problem, one could read about possible causes, view photographs of defective parts, and listen to recordings of typical noises caused by problems. One could then watch a video segment describing how to replace a part. Similar instructional manuals could be used to teach people how to operate military equipment, build their own airplane, or perform complex scientific experiments.

Introducing video disks for computer storage will be relatively easy, says Steven Yelick, another vice-president at Laserdata. "We're piggybacking on technology already developed for the movie video-disk industry." Using a mold made from a master disk, the disks can be mass-produced. A pattern of microscopic pits is pressed into the face of each disk. These pits store information by changing the reflectivity of the surface.

The computer video disks used by Laserdata, Online Computer Systems, and Matrox Electronics Systems can be played on any commercial video-disk player. These companies provide an interface unit that converts the modulations in the reflectivity of the disk into digital code used by the computer. Access Unlimited's sytems will use a combined video-disk player and interface unit sold by the company.

A technologically similar device, the "optical" disk, may be used increasingly to store data such as payroll lists entered directly from large computers. The computer controls a laser device that etches the information onto the disk; it can be read back at any time. Optical disks are already being marketed by Toshiba and Matsushita, and over a dozen other Japanese and U.S. firms will soon be producing the disks. They cost about $1,000 today, but the price is expected to drop to $100. Because optical disks must be individually recorded, they will not compete with the mass-produced video disks for information publishing.

Given the large potential market and the available technology, one wonders why video disks haven't been used for information storage before now. "No one got around to it," says Yelick. The idea was proposed shortly after video disks were first marketed, but it took a long time to combine two technologies—computer and video—and bring the system to reality.—*Frank Lowenstein* □

And Now for the Isotope Crisis

Say "isotope" and most people think "radioactivity." Wrong, of course: there are hundreds of stable isotopes—atoms of elements different in structure from their most common forms. These stable isotopes have vital roles in science and medicine and in the U.S. are produced chiefly at the Oak Ridge National Laboratory.

But the supply is faltering, Gerhart Friedlander of Brookhaven National Laboratory told the American Chemical Society. "Further deterioration of the inventory appears inevitable," Friedlander warned, posing "serious consequences for many areas of physics, chemistry, biology, and the geosciences." Continued erosion of the supply for nuclear medicine, he said, "could threaten the health of millions of patients."

A recent survey of 1,000 academic physics, chemistry, and geology laboratories showed 220 different stable isotopes in use within a three-year period; their cost: $1.6 million. Nearly 50 were listed as important in pharmaceutical research and development by Richard M. Lambrecht of Brookhaven.

Stable isotopes are used as "tags" to track chemical reactions, especially in biology; as targets and shields for particle beams in research on atomic structure; as sources of radioactive isotopes; in measuring isotope concentrations in geological materials; and in many other ways. Stable isotopes are responsible for "essentially all of our current understanding of the age of the earth, moon,

PHOTOS: M.I.T. ARCHITECTURE MACHINE GROUP

and solar system," D.J. DePaulo of the University of California at Los Angeles told the ACS. Michael Zisman of Lawrence Berkeley Laboratory said that substantial amounts of calcium-48 atoms (each has eight extra neutrons) will be needed in the next five years as projectiles in nuclear accelerators used to search for superheavy elements.

The United States depends for essentially all this material on a specialized electromagnetic separation facility at Oak Ridge. But some 60 isotopes on the Oak Ridge list are more or less permanently out of stock as the facility concentrates on producing materials in highest demand. That's why early in 1982 Zisman found 15 percent of a large sample of physicists, chemists, and geologists dissatisfied: the stable isotopes they needed for research were either unavailable or inadequately purified.

The isotope problem—like so many others—is one of money and management. Stable isotopes are sold or loaned (for nondestructive applications) to users at prices designed to cover the cost of operating the Oak Ridge separators. But the money from sales comes in months or even years after the costs have been incurred, and the production facilities look like a cost center to Washington administrators.

After a detailed study, members of the National Research Council workshop last year made three urgent recommendations:

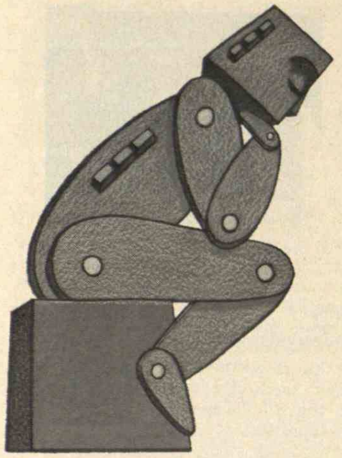
☐ Increase production of stable isotopes at Oak Ridge to more fully utilize the electromagnetic separation plant. It's the only major source outside the Soviet Union for most stable isotopes, a vital link between science in the United States and the rest of the free world. Eugene Newman, who heads the Oak Ridge isotopes center, has money to operate the electromagnetic separators at only about half capacity. With a budget adequate for full production, he told *Chemical and Engineering News*, he could solve the problem and recover the new investment from sales within two years.

☐ An advisory committee should be established to assure that supplies are adequate and distribution equitable. It would help Oak Ridge forecast demand and schedule production.

☐ Oak Ridge should begin research and development on alternatives to electromagnetic separation for producing isotopes. Some specialized systems may be available for producing certain isotopes at lower cost.—*John Mattill* ☐

Artificial Intelligence in a Rut

Despite a rash of publicity, the field of artificial intelligence (AI) has reached a plateau, producing few new ideas on how to make computers think. U.S. companies involved in AI are capitalizing on research published 10 to 15 years ago. Recent advances in computer hardware, for instance, have made it possible to develop "expert systems" from an AI theory published in 1969. Expert systems are computer programs that simulate the knowledge of human experts; they can, for instance, analyze geological data and advise oil companies where to



drill and help doctors diagnose disease.

"These programs are exciting," says Marvin Minsky, a professor of computer science at M.I.T. "But most of them are not very deep."

Minksy believes the U.S. software establishment "is in terrible shape" because computer scientists are not paying enough attention to the basic problems of AI. "You don't see researchers working on the problem of commonsense reasoning, for instance," he says. "There is no program around today that can tell the difference between a dish and a cup."

Other AI experts agree. "There have been some new insights in the last decade," says Pat Hayes, professor of computer science at the University of Rochester. "But they have emerged accidentally from work in other areas" such as mathematics.

Minsky blames this state of affairs on the fact that many talented young hackers with the ability to write complex programs are being snatched up by industry to work on more applied—and lucrative—research. "It's a fight for talent," he says, having watched many of his proteges at M.I.T.'s Artificial Intelligence Laboratory leave for jobs in industry. "The commercial interests in the field are draining people away as soon as we train them."

Ironically, companies working on AI are experiencing the same shortage of brain power. At an AI conference at M.I.T. last March, a number of executives from leading computer firms told participants that recruiting AI researchers was one of their major problems. "It's taken us a long time to recruit the right people," said James Baker, an executive with Schlumberger Technology Corp. And most of them have come from AI programs at M.I.T., Carnegie-Mellon University, and Stanford. In the last five years, Schlumberger has recruited five doctoral students in AI—20 percent of the total crop—from M.I.T. alone.

As a result, Minsky says, "Universities don't have the people to think about basic AI problems for four or five years." Yet that's exactly what's needed: more researchers who can spend substantial periods of time thinking about a theory and writing a computer program that proves it (or a variation).

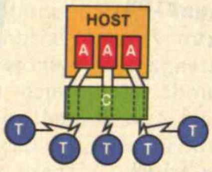
Minsky suggests establishing five-year or ten-year postdoctoral fellowships in AI to induce talented students to remain in basic research. These fellowships could be much like those in medicine, which are usually privately endowed.

"In the university environment, there are a few such fellows in AI," Minsky says. "But most are supported by grants that are too purposeful. Many large companies that fund the grants still don't understand where new ideas come from."—*Alison Bass* ☐

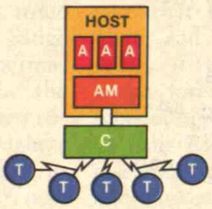
ILLUSTRATION: JAMES STEINBERG

Figure 1. *EVOLUTION OF SNA NETWORKS*

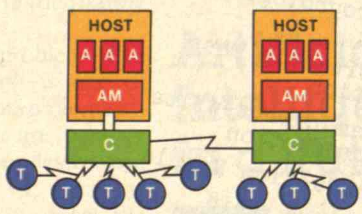
Legend:
A = *application program*
AM = *access method*
C = *communications controller (concentrator/multiplexer/front-end)*
T = *terminal or peripheral processor*
═══ *channel connection*
—Z— *communications link*



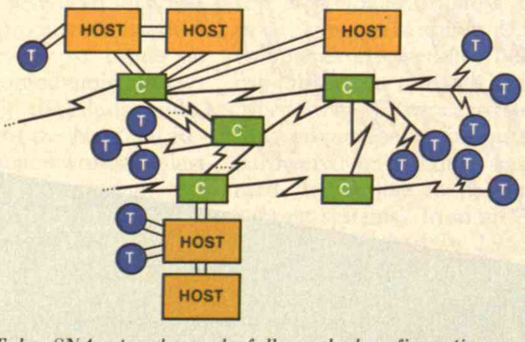
(a) In a typical pre-SNA network, communications links and terminals were dedicated to single uses or applications. All terminals on a link had to connect to the same application program, which included communications software. Usually, changing the terminal or link connections also forced the application programs to be changed.



(b) Early SNA introduced sharing of links among various application programs. A host access method permitted easy access from any terminal to any application program in the host processor. The connections could be readily changed without affecting the application programs.



(c) Subsequently, SNA configurations were enhanced to allow access between host processors for distributed processing and data-base sharing. Moreover, any terminal could access any application program at any host.



(d) Today, SNA networks can be fully meshed configurations. Parallel links between adjacent communications controllers allow increased network availability and traffic balancing. Access from host to host and terminal to host is permitted over multiple routes. The number of different types of network nodes has increased considerably, particularly among terminals and peripheral processors. SNA networks include open interconnection of both IBM and non-IBM nodes.

Advances in computing, processing and communications technologies have prompted increased interconnection of terminals, processors and communications facilities.

These various devices have been linked into networks for distributed access to processing and data-base resources.

A variety of networking applications has been developed for airline reservations, banking, store checkout, process control, remote job entry, office systems and personal computing.

Networks include a broad range of cost/function trade-offs and technologies, in such diverse components as analog/digital converters, specialized and general-purpose terminals, line concentrators and multiplexers, communications links and low- to high-capacity processors.

The networking environment requires a master interconnection strategy so that these diverse products and applications can share computational and communications facilities while interacting compatibly.

Since its introduction in 1974, IBM's Systems Network Architecture has provided the blueprint by which the capabilities of IBM networking products have evolved in an orderly fashion. SNA provides rules for all levels of interaction, from physical/electrical interconnection of computing devices and terminals to meaningful application-oriented processing.

Thus one uniform design now eliminates the complexity and inefficiencies inherent when each type of product had to have its own specialized agreement with each other type. SNA is now integrated into the whole range of IBM products—from large mainframe computers to terminals to personal computers.

By eliminating the chaos once caused by incompatible implementations, SNA allows a computer user to communicate from office to office or from continent to continent.

An important feature of SNA is the organization of functions into multiple layers. In the most basic sense, different products can be configured into networks simply by adapting them to the transmission and electrical characteristics of the media interconnecting them. But physical interconnection does not result in meaningful communication. The lower layers control only the basic transfer of bits, while the higher layers support meaningful exchange of messages and documents and allow application-

Systems Network Architecture

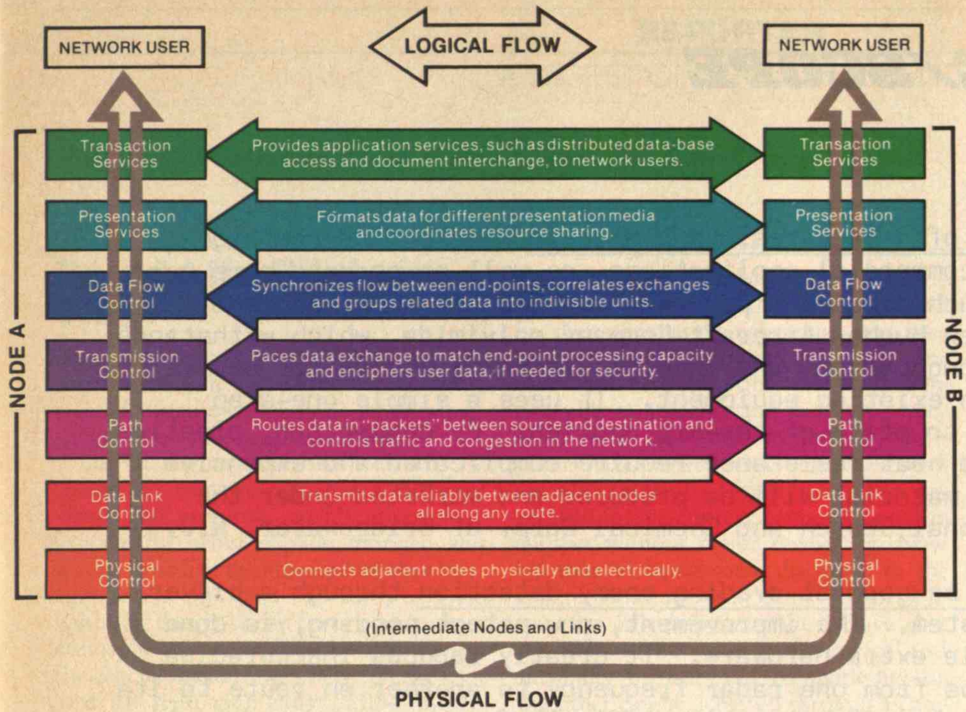


Figure 2. *Each node in an SNA network separates functions into multiple layers. Logically, a given layer in one node communicates with the corresponding layer in another node. This peer-to-peer communication relies on lower layers to transport the data.*

program interactions and data-base sharing. SNA's separation of independent functions into multiple layers means that changes in technology and capabilities can be confined to individual layers. This modular design eases adaptation to network evolution.

SNA includes a variety of functions at different layers of the architecture. For example, SNA's Synchronous Data Link Control offers increased efficiency over earlier techniques. State-of-the-art advances also have been made in traffic routing, congestion control and network availability. Additionally, SNA office systems provide document encoding uniformity and support distributed interchange, filing and retrieval services.

SNA has also incorporated protocols adopted by national and international standards organizations. This means SNA is compatible with standards such as X.25 public packet switching, High-Level Data Link Control and the Data Encryption Standard.

SNA management aids include product capabilities and software tools for planning, installing, changing, operating and maintaining networks. In today's environment, where annual growth and change typically can involve 20-50% of a network's facilities, aids such as these are critical to reduce operational expense and to foster optimal levels of network availability and performance.

IBM scientists, programmers and engineers around the world have spent collectively thousands of years of development on SNA. They continue to improve SNA's usability, manageability and performance, and also to extend its capabilities. Recent studies have focused on local-area networking, more dynamic reconfiguration within networks and interconnection of independent SNA networks.

SNA's success in reducing customer cost, while promoting ease of development of network applications, is reflected by a recent milestone —more than 10,000 large-system installations now incorporate SNA networking technology.

Systems Network Architecture is one example of IBM's commitment to product and technological leadership. Last year IBM's total worldwide investment in research, development and engineering was $3 billion.

IBM

For free additional information on SNA, please write:
IBM Corporation, Dept. 605F/002
P.O. Box 12195, Research Triangle Park, NC 27709

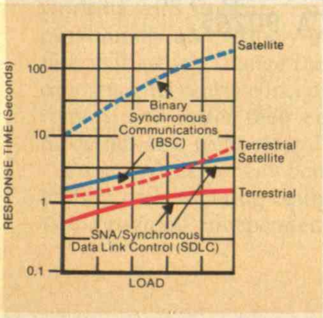


Figure 3. *Illustration of dramatic improvements in response time (using comparable display terminals) of SNA/SDLC over older data link controls such as BSC. For long-propagation-delay circuits, such as in satellite technology, the improvements in response time can be better than an order of magnitude.*

SCIENCE/SCOPE

An easily processed version of a heat-resistant plastic should find new high-temperature industrial and commercial applications, as well as promote more use of advanced composites in such aerospace products as aircraft, engines, and supersonic missiles. The new Hughes Aircraft Company polyimide, which withstands temperatures of 600°F for long periods and much higher temperatures for short periods, can be processed in existing equipment. It uses a simple one-step curing process very similar to state-of-the-art epoxies. By comparison, plastics with equivalent strength and heat resistance require complicated and expensive curing procedures. The new material will be produced and marketed under the trade name Thermid® by National Starch and Chemical Corp. of Bridgewater, N.J.

The new AMRAAM missile will be good at evading enemy detection through a clever improvement to its radar system. The improvement, now patent pending, is done simply and with only a little extra hardware. It greatly reduces inaccuracies caused when the missile jumps from one radar frequency to another en route to its target. Frequency hopping makes it extremely difficult for enemy radar-detection equipment to get a fix on the missile. Hughes designed and developed the Advanced Medium-Range Air-to-Air Missile for the U.S. Air Force and Navy.

An advanced antenna farm designed with the aid of a computer will be carried by Intelsat VI communications satellites. The system will provide different kinds of coverage -- beams transmitting to entire hemispheres, "global" beams, focused regional beams, and very narrow spot beams for broadcasting high-speed data. Hundreds of computer patterns were created to predict antenna performance. These studies led to the choice of transmit reflectors 3.2 meters in diameter instead of 4 meters. The larger size offered only slight improvement at the cost of being much heavier, larger, and more complex. Hughes heads the team building Intelsat VI for the International Telecommunications Satellite Organization.

A wide-field-of-view head-up display can provide pilots with critical sensor and steering information in low-altitude flights at night and under poor visibility conditions. Head-up displays save a pilot from looking down at his instruments by superimposing such data as airspeed, heading, and target information on a glass-like combiner mounted at the pilot's eye level. Hughes pioneered the technology used in its HUD, which incorporates diffraction optics made through a process involving holographic techniques and lasers. The display is brighter, more transparent, and doesn't obstruct the pilot's forward vision. It also resists glare, reflections, and hot spots caused by the sun.

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Could Life Begin in Clay?

Most answers to the question of how life began on earth speculate that lightning created organic compounds in an atmosphere of ammonia and methane.

But Dr. Hyman Hartman, research associate in meteorology, has a different view. The primitive earth's atmosphere was mostly carbon dioxide, nitrogen, and water—just like the atmosphere that Voyager found on Mars—he says, and the lightning theory doesn't work in such an atmosphere. Instead, Dr. Hartman thinks, the crucial reaction was between the CO_2 and an iron-rich clay called montmorillonite: in the presence of ultraviolet light, the clay can convert small amounts of CO_2 into formaldehyde. Such reactions could have led to a clay—organic system energized by sunlight through which life as we know it could have evolved in the shallow water of a primitive planet. □

Computers as Educators

Computers are not only changing the way we do business, says Dean Gerald L. Wilson of M.I.T.'s School of Engineering. They're changing our whole "creative environment—the way we interact, the way we deal with problems—even the way we think.

"They enable us to deal with complexity generically, in almost every shade and color of our lives."

And it only follows that computers must affect the way we learn, says Dean Wilson in expressing his enthusiasm for Project Athena, a $70 million program to develop a coherent system of computers and programs that will be a basic educational tool in every field at M.I.T.

Too much learning relies on a classroom-homework environment where there's too little "timely feedback" between student and teacher, says Dean Wilson. Project Athena can change that, he thinks: "We believe that our faculty, working with students, can develop computationally and visually interactive tools that will greatly change the way in which our students learn concepts, develop intuition, and foster their creative abilities to design new technology."

Project Athena will benefit from $50 million of computing equipment and service provided independently by Digital Equipment Corp. and IBM.

Perhaps the most difficult problem will be that of creating coherence—the idea that the fruits of Project Athena in one field will be compatible with software available to students and faculty in every other field. Like most technology, computers have evolved without the benefit of standardization. Often software developed in one context cannot be used in another without major reworking. Now it's time to bring some discipline to the system—a tough task, thinks Dean Wilson. But he's hopeful: "We believe that the balance between performance and flexibility on one and compatibility on the other can be achieved through a careful interplay of administrative means and 'free-market' forces," he writes in Project Athena's proposal. □

Quantitative Liberal Arts

Grants of over $3 million have been made by the Alfred P. Sloan Foundation to 31 independent liberal-arts colleges with the goal of "reestablishing quantitative study as a natural and integral part of a liberal education." Under a small grant within the program, M.I.T. will arrange conferences between major universities and the liberal-arts colleges, seeking ways for future collaboration—such as shared teaching materials and other resources—in quantitative modes of thought. For the Sloan Foundation it's the start of a new effort titled the New Liberal Arts Program, in which total grants may be as much as $3 million a year for the next six years or more. □

How U.S. Decontrol Helps Us, Hurts Others

Oil price decontrol may be far more profitable to the United States and less profitable to the OPEC countries than most of us assume.

The idea of decontrol is simple enough: the higher prices that result when oil takes its proper value in the marketplace stimulate both conservation and exploration. The other side of the coin is that those higher prices will bring all producers—including notably the OPEC countries—a bonanza of more money for their product.

But it's really not quite so simple, says Professor Paul Krugman of the Department of Economics. The United States is part of an intricate network of oil producers and consumers—and all these people buy and sell other goods, too. As oil prices go up, the U.S. reduces its oil purchases from OPEC, and the OPEC countries accordingly buy fewer foreign goods—a reduction in spending that affects other exporters more than the U.S. Result: the U.S. dollar—and with it the costs of U.S.-made goods—appreciate on the world market.

U.S. purchasers then find they can buy more foreign goods for their dollars, and U.S. imports increase. But U.S. exports decrease. Eventually these changes—decreasing exports and increasing imports—restore equilibrium to the U.S. balance of payments, but by then the U.S. will have improved its position in the international market: we'll be receiving more imports in exchange for our exports.

The big losers in all this are the foreign oil-importing nations. OPEC nations buy less from them and at the same time their terms of trade with the U.S. worsen. □

Why Decontrol Is Bitter Medicine for the Poor

Oil price decontrol may help the U.S. position in international trade (*see above*), but it does not affect Americans evenhandedly: there are significant social inequities.

Modeling family and regional patterns in the U.S., Professors Dale W. Jorgenson of Harvard, Thomas M. Stoker of M.I.T., and Lawrence J. Lau of Stanford find that the fraction of a family's income expended for oil decreases as expendable income increases. Furthermore, when expendable income changes, poor people change their energy share more than rich people do. But when prices change, rich people are more responsive than the poor. Taken together, these powerful negative feedbacks cause higher fuel prices to fall more heavily on the poor than the well-to-do.

Details remain to be analyzed, but Professors Jorgenson, Stoker, and Lau find that the impact of President Ronald Reagan's policy of decontrolling oil prices—while providing a net increase of $20 billion to the country's GNP over several years—has had negative effects on some consumers: people who are worse off are worse off by about $18 billion. □

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